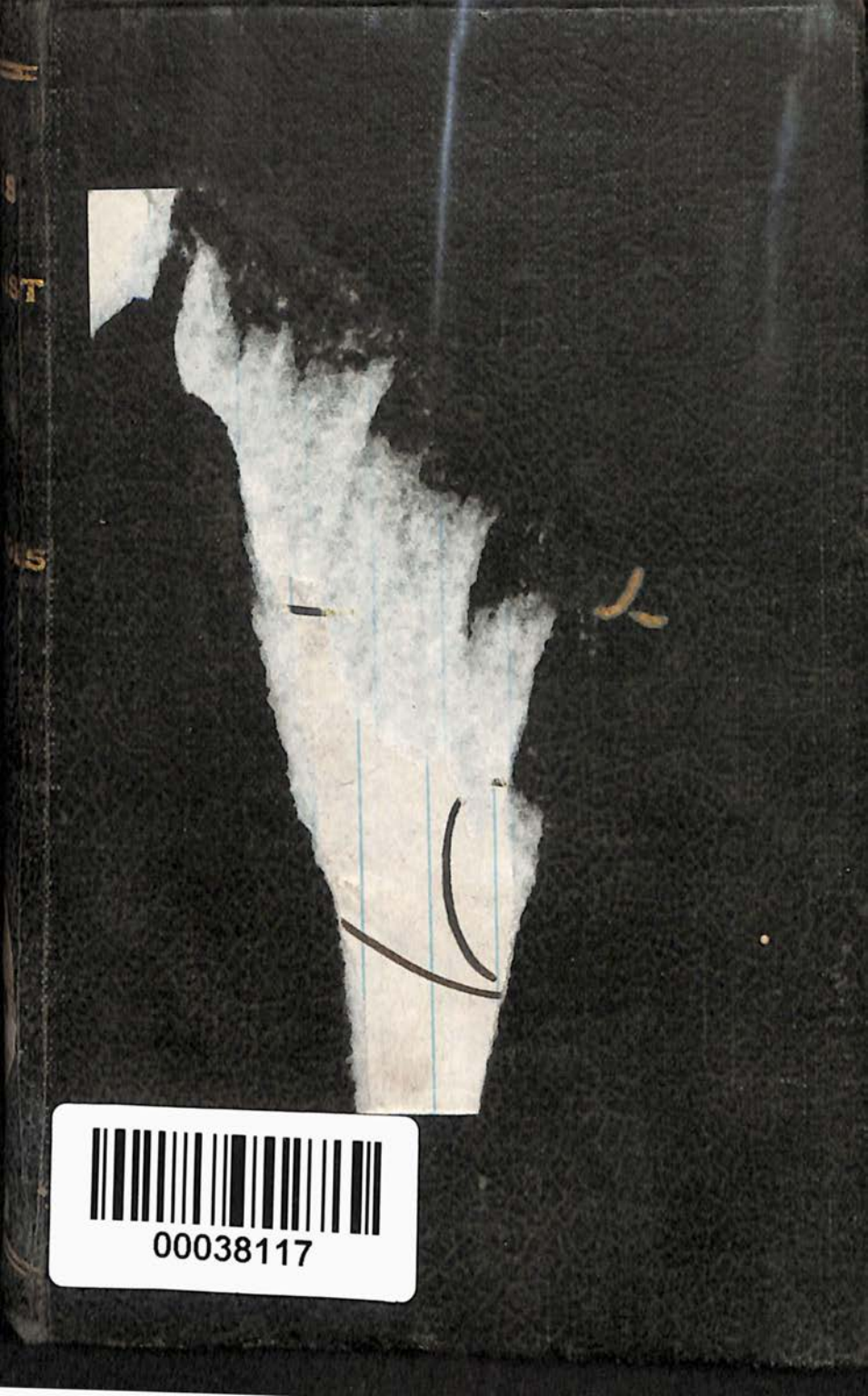
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THE

RAMBLES OF A NATURALIST

ON THE

COASTS OF FRANCE, SPAIN, AND SICILY.

BY

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ETC. ETC.

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TRANSLATED

(with the Author's sanction and co-operation)

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It had been our intention, when we first arrived in Sicily, to make the entire circuit of the island, but the information which we obtained in the course of our wanderings, gradually modified our original plans. Our men had now begun to comprehend the object of our voyage, and had learned, day by day, better to appreciate the conditions necessary to the success of our researches. Artese and Carmel,

who, from their perfect knowledge of the coasts, might have served as pilots, expressed strong doubts as to the utility of an exploration of the west coast, where, as they told us, we should find nothing but pestilential marshes, or shingle and sand. On consulting our maps, and considering the geological conformation of the district, we found that their statements were well grounded. Indeed, Sicily everywhere bears traces of those violent forces, which, by their action on the solid crust of our globe, have elevated this island above the waves. Amid the thousand irregularities which mark the contour of the land, and are the inevitable result of this mode of formation, we could perceive how differently these forces had acted at different points. To the west, east, and south-east, the low chains of mountains gradually slope towards the sea, and either terminate in undulating hills or merge into extended plains and low tracts of shore covered with salt marshes. A few isolated peaks, which, in some cases, are of an entirely volcanic origin, like Monte-Rosso, rise above the others, although few attain a height of more than 2000 feet; Monte-Caramata is, indeed, an exception to this rule, for its calcareous rocks, which command the town of Orte, rise to an elevation of 4000 feet. In the centre of the island the mountains are higher, and several of them have an altitude of more than 3000 feet; still, the true mountainous region of Sicily lies in the north and north-east of the island. Here the subterranean forces, acting with their whole intensity, have protruded huge masses of gneiss and granite through

the strata of limestone, of sandstone and argillaceous schist formations. The Pelorian and Madonian chains * exhibit numerous summits, which rise upwards of 4000 feet above the level of the sea; some even exceed 5000 feet; and one of them, the Pizzo di Palermo, attains an altitude of nearly 6000 feet.

These high mountain-chains, which extend like a wall from Palermo to Messina, are broken here and there by the intervention of a cape or a small peninsula, whose deeply indented shores seemed to promise us an abundant harvest. After much deliberation, it was decided that these should form the scene of our next explorations on leaving Favignana. In order to lose no time by this retrograde movement, we resolved once more to leave our boat; and having given Perone orders to await our arrival at Cephalu, we set forth, accompanied only by the faithful Carmel, and, guided by the muleteers on whose mules we were to make the journey, traversed a part of Sicily which is very rarely visited by strangers.

Here, as at Trapani, we everywhere observed mournful traces of deficient civilisation, associated with the remains of the splendour of a bygone age. The church of Castelvetrano, in which lie the re-

* The Pelores mountains, formerly known as the Neptunian chain, border the whole north coast of Sicily from east to west, and seldom deviate far from the coast line. The Madonian chain, which was designated by the ancients under the name of the Nembrodes, is situated to the south of the preceding range, extending in the same direction. Numerous less elevated branches join these two larger chains, intersecting the district of Sicily in every direction.

mains of the conqueror of Lepanto*, is crumbling to ruins, with all its treasures, unheeded; while, at a distance of six miles, lie the colossal ruins of Selinonte†, the ancient rival of Carthage and of Syracuse. At Salemi and at Calatafimi, the old Saracenic and Norman castles have opened their dismantled keeps to a ragged population, in whom our presence seemed to excite the most indescribable astonishment. At Alcamo, a town containing 20,000 inhabitants, and having broad well-paved streets, which is situated on the only high road of Sicily, and is one of the principal places of resort of the Palermo grandees when they do chance to travel, we were obliged, as everywhere else, to lend the landlord of the hotel money to buy our dinner. Through the whole of our journeyings, along unbeaten tracts as well as in the high road, every traveller we met had a loaded carbine slung across his saddle

* Amongst the other curiosities contained in this church I may instance, in addition to the tomb of Don John of Austria, the four Sibyls, which are placed side by side with the four Evangelists in the Choir.

† The town of Selinonte, which was almost always at enmity with Segeste, and often in alliance with Syracuse, continued for a long time to prosper in its wars. It succumbed for the first time to Hannibal; but the inhabitants, having been brought back to the charge by Hermocrates, re-took the town. Although Selinonte was almost always a tributary of the Carthaginians, it promptly revived, until, being successively besieged by the Syracusans and the Carthaginians, it called the Romans to its aid, and soon fell to rise no more. No ancient city in Sicily affords so high an idea of the religious feeling and of the wealth of its inhabitants, as Selinonte Accumulated in a vast solitude, bounded by distant mountains and the neighbouring sea, these colossal ruins and memorable sanctuaries strike the imagination with astonishment.

— a precaution which either betrayed an adherence to the manners of a bygone age, or the necessity of being prepared for the chance of existing danger. To crown all, the cultivation of the potato* had not

* Botanists call this plant the *Solanum tuberosum*. We would observe here that the tubers, or tubercles, which we eat, are not the roots of the plant, as is generally supposed, but true subterranean stems or branches, which are enlarged at different parts, and which owe their nutritive properties to the great quantity of amylaceous matter or starch which they contain. We will extract from M. Duchartre's work, the following historical details in reference to the origin and the progress of the cultivation of the potato in Europe: —

"The potatoe was known from time immemorial in Peru, where the inhabitants designated it by the name of *papas*, but the true place of its origin has not yet been precisely determined. It was introduced into Europe about three centuries ago, for it would appear that Captain John Hawkins first brought it to Ireland in 1565, having procured a few roots at Santa Fé de Bogota. These plants were, however, entirely neglected; but the celebrated navigator, Francis Drake, who had been the companion of Hawkins, fully comprehending the importance which this acquisition might prove to Europe, carried some of these plants to Virginia, from whence he afterwards conveyed them to London in 1586, and this circumstance has led to the belief that the potatoe was a native of Virginia. Drake gave his specimens to his own gardener, and amongst others to the botanist Clusius, who was the first to recognise the botanical character of the plant. The new plant was, however, entirely forgotten, until Sir Walter Raleigh, finding it again in Virginia, brought a large number back with him to England in the beginning of the seventeenth century, and this time the introduction of the plant proved definitely successful.

"Still the cultivation of the potatoe made very slow progress, and a convincing proof of its scarcity is shown by the fact, that in 1616 a dish of these vegetables appeared at the table of the King of France as a rarity of high price. It did not penetrate into Germany till 1650, and until the close of the eighteenth century was only cultivated in limited districts. It was through the efforts of Parmentier that it became generally diffused in France; and probably

yet penetrated to this region—a fact which, perhaps, more than any other, illustrates the stationary condition of this part of Sicily; indeed, during the whole time in which we were stationed west of Palermo, we were never able to procure these vegetables, which everywhere else constitute an almost unfailing resource to the poor.

The road which we had taken led us back to Palermo. We once more passed through this town, after having admired, for the last time, the strange and magnificent church of Morreale; we took a hasty survey of the castle of La Bagaria, which stands in the midst of its princely villas like a king surrounded by his court; we next reached the ancient Himera which, under the modern name of Termini, yearly attracts a vast crowd of persons who come to seek health at the warm springs for which this place is celebrated. This part of our journey afforded us the greatest possible enjoyment, for the weather, which had previously been cold and rainy, had become fine and settled within the preceding few days, whilst the land displayed in every part a most exuberant vegetation. Our road followed the irregularities of the coast, skirting from time to time at the foot of mountains, and was sometimes bordered with rose-laurels in full blossom*, and

his attempts would have proved ineffectual, had not the famine which followed the first wars of the revolution compelled men to submit their prejudices to the pressure of necessity, and in a few years' time the potatoe spread to the smallest villages of France."

* The shrub which is designated by this name, belongs, in reality, neither to the genus or family of the Laurels, but to the genus *Nerion*, and to the family of the *Apocynaceæ*. The species to

sometimes by tall, shrub-like Solanaceæ*, in the midst of which rose the smooth stems of the gigantic Agave†, which were often upwards of twenty feet in height. Long-tendrilled vines encircled, with their indented leaves, the trunks of the flowering Cactus, and blended their light and graceful garlands with the strangely twisted branches of these un-

which we here refer is the one generally cultivated in our gardens. It grows wild along the brooks and streams of almost all the districts skirting the Mediterranean, and hence its abundant occurrence on the shores of the Eurotas was not an exceptional case. Botanists designate the shrub under the name of *Nerium oleander*.

* The family of the *Solanaceæ* is very remarkable on account of its including plants, some of which are thoroughly impregnated with the most deadly poisons, whilst others, on the contrary, yield substances which are alike nutrient and agreeable to the taste. Among the former, we may instance Belladonna (*Atropa belladonna*), the Mandragora (*Atropa mandragora*), Henbane (*Hyoscyamus niger*), Stramonium (*Datura stramonium*), Common Night-shade (*Solanum nigrum*), Tobacco (*Nicotiana tabacum*). All these plants owe their poisonous properties to special principles, which chemists have succeeded in isolating, and which they have called, in accordance with their various sources of origin, *Atropine*, *Hyoscyamine*, *Daturine*, *Solanine*, *Nicotine*, &c. Among the edible plants of this family we may mention the Pimento (*Capsicum annuum*), the Tomato (*Lycopersicum esculentum*), the Egg-apple (*Solanum melongena*), and more especially the Potato (*Solanum tuberosum*), whose history we have already briefly sketched in a preceding note.

† This species, which is incorrectly designated under the name of *Aloe*, belongs to another genus, and is the *Agave americana*, a native of South America. This Agave was imported into Europe in 1561, and is thoroughly naturalised in most of the countries bordering on the Mediterranean. In Sicily it grows wild among the rocks, and it is planted round fields to form hedges, which are rendered absolutely impenetrable by its enormous leaves, bristling with thorns.

wieldy plants. Woods of Olive trees, and groves of Orange, Citron, and Carob trees, gave variety to the landscape. Sometimes we caught a glimpse to our right of some small valley, lying within the recesses of the mountains whose sides were clothed with verdure enlivened here and there by patches of thickly clustering rose bushes, which were covered with a thousand small red or white blossoms, whilst to our left the sea stretched its bright blue horizon as far as the eye could reach, bounded by its picturesque and deeply indented shores, and by the lofty promontories, whose summits were often crowned with the rich tufts and expanded leaves of the tall date tree.

On approaching Cephalu, the experienced eye of Carmel had recognised the *Santa Rosalia* with her sails spread, hastening towards our place of rendezvous. Our bark and our mules arrived at the same time, and in a few moments we were steering towards the peninsula of Milazzo. For the first hour the shore along which we were sailing was as rich and beautiful as the one we had just left; but after a time the mountains increased in height as they approached the shore, and seemed, with their sharp and clear outlines, as if they had just emerged from the sea; but still they were green and richly varied. The scene was very different from that desolate region, and those arid and rugged rocks which had oppressed our sight westward of Palermo; here, everything betrayed the presence of man, and of a more active state of civilisation. Numerous villages appeared in the distance, their white houses

and turreted steeples rising from the midst of fields and rich clumps of trees, whilst almost every bay along the shore had its own group of habitations clustered around some protecting tower or fortress, whose services were fortunately no longer needed, since the conquest of Algiers. When we turned away from this picturesque landscape, which lay to the right of our boat, we saw before us the island of Lipari, which seemed gradually to rise from the bosom of the waves, its sister islets, Alicuri, Filicuri, and Saline forming at our left a vast semicircle, while behind us the sun, like a reddened ball, sunk beyond the arched promontory of Cephalu, bathing land, sky, and sea in a glowing tint of the richest ochre.

At the break of day, we were opposite to Milazzo*, and a few hours afterwards we had taken possession of most comfortable quarters, admirably situated for our researches. Through the kind intervention of the French Chargé d'Affaires, M. le Baron Lucifero had generously given us the use of his country-house, which was situated at the extreme point of the peninsula, and only at a few minutes' distance from either coast. Our tables were soon arranged and supplied with all the apparatus necessary for our work, and without further delay we began to explore our new domain.

Similar in this respect to the islands of Favignana,

* Milazzo is the ancient Milas, where the consul Duilius gained the first naval victory over the Carthaginians, 260 years before the Christian era. To perpetuate the memory of this triumph, the Romans erected a rostral column, which is still in existence.

Milazzo is never visited by the few strangers whom the love of travelling leads to Sicily. This little town, which entirely occupies the narrow isthmus on which it is built, is surrounded on the one side by the peninsula which bears its name, and on the other by a small plain which is partially enclosed by the semi-circular chain of the Pelorias mountains, behind which may be seen the distant summit of Mount Etna. Narrow paths, which are only practicable for the mules of the country, communicate with the high roads of Messina and Palermo.

The inhabitants of Milazzo, who are thus isolated from the rest of the island, appeared to us to exhibit much more energy and activity than the rest of their countrymen. We had nowhere met with so good a mode of cultivation, for not an inch of ground is lost either on the plain or the peninsula. Vines and Olives almost everywhere supply the place of the Cactus or the Agave, and descending to the very water's edge, they afford shade to the simply but elegantly built country-houses, whose terraces overhang the sea. A small harbour, which is well sheltered against the west and north winds, is favourable to the export of the different products of the soil, and this trade is sufficient to keep the population in a condition of ease and comfort. The streets near the harbour are broad and tolerably well built, but they change into winding lanes, as they ascend the steep hill, which, rising perpendicularly on the west side, is surmounted by a fortress which is manned by a tolerably large garrison. Milazzo was for several years the residence of Louis Philippe,

then Duke of Orleans, who, having been banished from France on account of his name, and not permitted to remain at the court of Naples on account of his liberal opinions, came to seek an asylum in this remote corner of the world. It may be, that in the midst of the splendours and the troubles that chequered his life while he was king of the French, he often recalled the humble white cottage which was pointed out to us by our guides as his former residence; and it may be, too, that even without foreseeing the sorrows of exile, he may often have regretted the calm and peaceful days he spent at Milazzo.

The peninsula of Milazzo consists of an irregularly-shaped and somewhat elliptically formed tongue of land, whose greatest width scarcely measures a mile and a half, but which extends nearly six miles into the sea at right angles from the shore. Its geological constitution is very remarkable; for the coast, from which it seems to take its origin, consists of sandstone for a considerable distance in all directions, but, as soon as we pass beyond the isthmus, we find that the rocks are composed of gneiss and mica schists, both of which are of more ancient origin. These rocks extend over the greater portion of the territory, and form in the centre of the peninsula a small mountain, known as the Monte Venereo. Beyond this we find strata of the same nature for a short distance, but these rocks soon disappear under beds of round pebbles, and sand transformed into sandstone rock. Beyond this again, on the borders of a steep cliff, there is a thin stratum filled with

fossils, belonging to the Palermo limestone, while the extremity of the cape consists of compact calcareous rock, which penetrates to some depth. This locality, therefore, presents in their order of natural superposition, specimens, as it were, of almost all the principal strata, which, either isolated or combined into large masses, compose more than two-thirds of Sicily.

These calcareous strata, of which we have spoken, have been worn away by the action of the waves, and hollowed into recesses and basins, in which grow thick tufts of Algæ and Fuci, which afford asylums to numerous marine populations. These excavations constituted so many preserves, which promised us the most ample success. We had also reckoned upon finding numerous representatives of different littoral species under the detached blocks of stone, which are here scarcely covered by more than a few inches of water, but we soon saw that an unforeseen circumstance would frustrate our hopes. Under the influence of conditions which are somewhat difficult to understand, but amongst which a more or less powerful evaporation undoubtedly plays an active part, the water of these seas in some cases dissolves, and in other cases deposits a certain quantity of the lime which it has removed from the submerged rocks. In the latter case, the calcareous matter is deposited like a sort of varnish on the surface of the stones and boulders, which it agglutinates to one another, and thus blocks up the passages, by which Annelids and Worms of every kind might otherwise penetrate into the interstices of the stone. This incrusting matter presented a very great resistance, and the

united efforts of our men, although they were provided with powerful levers, were often insufficient to displace a stone, which, had it been free, any one of our party could easily have moved with his unaided hands.

While this gradual deposition goes on, the sedimentary rock retains and encloses in the mass small isolated pebbles, and sometimes even the remains of human industry. This remarkable fact, combined with others of the same nature, at once explains and refutes the opinions of some geologists, who have attempted to refer the appearance of man on the surface of the globe to a very remote period. The sedimentary rock of Milazzo is of a very compact structure, and as it fully equals in hardness the primary limestone which it covers, it would be easy at first sight to confound the two. The discovery in rocks of recent formation of fragments of brick and earthenware might, therefore, lead to the inference that these remains were contemporaneous with the rock itself, if one did not bear in mind that a similar phenomenon is daily taking place before our eyes. The incrustation of the rocks of Milazzo is a fact analogous to those which have been observed on the shores of some of the islands of the Archipelago, and which are exhibited on a larger scale along the rocky heights of Guadaloupe. Here the sea has incrusted and united immense masses of sand and fragments of shells, converting them into a sort of *breccia*. In these breccias, human bones have been discovered, intermixed with a few traces of a rude stage of civilisation; but there were also found in the same deposits

different remains of European vessels that had been shipwrecked within the last few years. It is, therefore, evident that the formation of these marine rocks of Guadaloupe is proceeding with great rapidity, for their whole mass, although of considerable extent, belongs exclusively to the present geological epoch. The bones and *débris* of every kind which are found there cannot, therefore, be regarded as fossils, since this expression is limited to those organic remains which are contemporaneous with preceding geological epochs; and hence it may be said that in our day, no less than in the time of Cuvier, a true *fossil man* is a discovery that still remains to be made.

Notwithstanding the unexpected difficulty which the agglutination of the stones threw in the way of our researches, our sojourn in the peninsula of Milazzo was productive of much enjoyment to all of us. The daily increasing heat seemed to give rise to a marvellous development of life, both on the land and on the sea. Thousands of insects, many of which had never found a place in our zoological catalogues, were swarming over the fields and woods, and M. Blanchard found no difficulty in filling several cases with numerous and curious specimens. Some living reptiles, too, were caught and added to our collections, and they still constitute a portion of the special menagerie which was established at the museum by MM. Duméril and Bibron. We collected, amongst others, two large black snakes, which were perfectly harmless, notwithstanding their formidable appearance; and some fine specimens of the Gecko, an ani-

mal which is somewhat similar to a lizard, but whose flat body, short tail, and greyish skin covered with tubercles, give it a very repulsive appearance.

Like the majority of its congeners, this Gecko, which is vulgarly known as the Terrentola, is the terror of the inhabitants of the country, who regard it as very venomous, and watch with horror the rapidity with which it runs along the smoothest walls, on which its claws and the scales that cover its toes enable it easily to find points of support. Nothing, however, that we heard in regard to this animal can compare with the terrific reports that are made of it by some travellers in the East, and at the Cape of Good Hope. There the Geckos are regarded as accursed beings, disseminating death around them, sometimes causing their victims, by a mere touch, to perish in a few hours, and sometimes giving rise to an incurable leprosy by a slight bite.

It is not easy to determine how much truth there is in these evident exaggerations; but when we remember the absurd stories that are commonly circulated and believed in our country districts concerning the Salamander and the timid Newt, one is led to think that the Gecko may be a perfectly innocent animal, and that its nocturnal habits may have been the principal means of rendering it an object of terror.

Whilst M. Blanchard was carrying on an active war against these inhabitants of the land and air, M. Milne Edwards and myself were directing all our efforts to the sea; and to our various means of investigation we were now going to add another, which

was more powerful than any which we had hitherto employed. Instead of merely exploring the accessible parts of the shore, or dredging at hap-hazard, we were now about to descend to the bottom of the sea; and, in the enjoyment of perfect liberty of action, we were actually going to pursue the marine animals into their most hidden retreats within the recesses of those rocks, which were so deeply buried beneath the waves as to appear to defy all our efforts.

The execution of this project, the idea of which originated with Milne Edwards, demanded some precautions. First, it was necessary to be well assured of the working condition of our apparatus, and so to combine and arrange its different parts, as to foresee all possible accidents, and to secure the means of remedying them, should they occur. In the course of a few days, everything was arranged, and after some preliminary trials, M. Milne Edwards made his first submarine excursion within the harbour of Milazzo. For more than half an hour, he remained at the bottom of the sea, which he traversed in all directions, turning over the stones, examining frond by frond the tufts of Algæ, and collecting together and observing on the spot the different zoophytes which live at a depth of from ten to thirteen feet below the surface of the water. After this first attempt, M. Edwards descended to much greater depths; and in the Bay of Taormine and elsewhere, we saw him, at a depth of upwards of twenty-five feet below the surface of the water, working for more than three-quarters of an hour to detach with a pickaxe some of those large Panopeas of the Me-

diterranean, which had been known only by their large bivalve shells.

The apparatus employed by M. Milne Edwards in these submarine explorations was that which had been invented by Colonel Paulin, a former Commandant of the Fire Brigade of Paris, to be used in case of fires in cellars. A metallic helmet, provided with a glass visor, encircled the head of the diver, and was fastened round the neck by means of a leather frame supported by a padded collar. This helmet, which was in truth a miniature diving-bell, communicated by a flexible tube with the air-pump, which was worked by two of our men, whilst two others stood ready to replace their companions. The rest of the crew, under the orders of Perone, held the end of a rope which, passing through a pulley that was attached to the yard, was fixed to a sort of harness by which we were enabled quickly to draw up and embark the diver, who had been drawn to the bottom of the water by means of heavy lead soles, which were kept in their places by strong straps. M. Blanchard took charge of the air-tube, and watched that it did not become twisted by the different movements made by M. Edwards or by the swaying to and fro of our boat, while I retained in my hand the rope by which the diver was to make his signals, and God only knows with what anxiety I watched its faintest motion. This will be readily understood on considering that the slightest mistake might have proved fatal to M. Milne Edwards. Notwithstanding all our care, the means of safety at our disposal were very imperfect; for it

required fully two minutes to draw the diver from the water and loose his helmet. On one occasion the yard cracked, and threatened to break at the very moment when I had given orders to haul in the rope under the impression that I had received a signal of distress; our men instantly sprang towards the water, and they would soon have brought M. Edwards to the surface, but more than five minutes elapsed between the moment when I thought I felt the cord move, and that in which M. Edwards was able to breathe the air freely; and this length of time would have been more than sufficient to determine a fatal condition of asphyxia. Happily, however, I had been deceived by an involuntary motion imparted to the telegraphic line; but one may easily perceive that researches of this nature were not devoid of danger, and it certainly requires an amount of zeal very uncommon among naturalists of our day to risk so perilous an undertaking.

M. Edwards, however, reaped an ample harvest as the reward of his labours; for each time that he returned from the bottom of the sea, his box was richly laden with Molluscs and Zoophytes. The most precious, however, of all the treasures which he collected from these submarine depths, was an immense quantity of the ova of Molluscs and Annelids. After being deposited in small basins, to which the waves entered merely by penetrating through the walls of dry stones which had been raised around them, these eggs continued to be developed, and thus enabled M. Edwards to study

at his leisure every phase of their curious evolution. I for my part found in the grottoes of the Cape a large number of Annelids, Nemertes, Planarias, and Phlebenterous Molluscs, and I also discovered a new species of Gasteropodous Mollusc allied to those Tritonias, whose organisation was first made known to us by Cuvier. The Sicilian species, although of smaller size, is much more remarkable than the one which inhabits the coasts of France. Figure to yourself a little slug of a somewhat elongated shape, bearing on its sides a row of branchiæ, looking like so many exquisitely delicate living tufts. In the place of the smooth and opaque tentacles of our snails, imagine two large crystal horns, from each of which escapes a tuft of rosy branches, intermingled with violet-coloured blossoms; and lastly stretch over the front part of its head a spangled veil of the finest gauze, and you will have some idea, although a very imperfect one, of this lovely little creature, which is one of the most marvellously beautiful living gems that I have ever seen.

Although the localities adapted for our researches on the isthmus of Milazzo were rich in animal species, they were of limited extent, and three weeks sufficed to exhaust them: this circumstance, together with the advanced season of the year, combined to make us think of hastening our departure. From the terraces of the Villa Lucifero, we could perceive a black cone rising abruptly from the sea, which was almost always encircled by a light cloud of smoke. This was the island of Stromboli, whose

volcano being in a state of incessant activity, serves as a natural beacon light to vessels passing from Naples to Messina. After having visited the granitic, schistose, and calcareous rocks, and after having studied the populations belonging to each of them, we wished now to compare them with the coasts and fauna belonging to volcanic districts. We therefore set sail for Stromboli, and the evening of our departure was followed by one of those glorious nights which seem to appertain especially to the favoured climes of the South. The sun had disappeared in the west in a bed of gold and purple, the stars had risen in the east and spread over the entire vault of heaven, while the thousand rays of their phosphorescent and quivering light threw so bright a gleam over land and sea that we were now able to distinguish, as through a thin and filmy veil, the distant chain of the Pelorian mountains, and the summit of Mount Etna. The wind was blowing gently from the south, at one time swelling our lateen sail, and at another letting it flap loosely against the mast, so that our sailors were obliged to have recourse to their oars. One of our men would then begin a monotonous song, while the oars, rising and falling in cadence with the voice of the singer, seemed to harmonise with the rhythm of his wild and sonorous chant. Each stroke of the oar, was followed by a tremulous phosphorescence which, vanishing almost as soon as it was perceived, revealed to us the presence of those minute animalcules which produce light as the torpedo engenders electricity. When the breeze again sprang up, the

chant ceased, and the oars were drawn in and laid along the side of the boat, while our men, stretched upon their benches, resumed their interrupted slumbers, and the light splash of the water round our prow was the only sound that broke upon the silence of the sea, which is at all times deeper than that on land. We continued for a long time to admire this scene, whose grandeur was due to its calm simplicity, and then stretching ourselves upon our mattresses, which were screened by a slight awning, we too fell asleep, soothed to rest by the scarcely perceptible oscillations of our boat.

By break of day we were all again on the alert. The Cape of Milazzo was very far behind us, and yet Stromboli seemed to be scarcely any nearer. In these warm regions the extreme transparency of the air for a long time deceives the northern traveller as to the actual length of distances. We had thought when we left Milazzo that we were not more than twelve or fifteen miles from Stromboli, instead of which these two points are in reality separated by about forty miles. We had scarcely made half the distance since the preceding evening, but at this moment the wind freshened, and the dark mountain seemed to grow before our eyes as we rapidly approached it, and we were soon able to distinguish its rugged sides, its lava and trachyte beds, its strangely twisted rocks with its beach of fine sand, which was black like the rest of the island, excepting where the waves as they broke seemed to leave a line of milky foam in their wake.

Stromboli, properly speaking, is only a volcanic

cone, measuring about nine miles in circumference, and rising to a height of about 2000 feet above the level of the sea. To the south the declivity, which is composed of old scoriæ, becomes a little less steep, and forms a narrow and inclined plane, over which are scattered about thirty houses, the materials of which have all been supplied by the lava. A few other habitations are clustered together in the north of the island in a somewhat similar locality, and here a little white-washed church forms a striking object by its contrast to the dark rocks around it. In the midst of the lava and scoriæ which have been decomposed by the slow and gradual action of succeeding ages, a few garden vegetables and some vines are cultivated, but the produce of these plants would be insufficient for the maintenance of the population, if they did not find lucrative employment in the coral fishery.

The mode of collecting the coral, which we had an opportunity of observing, remains at the present day the same as it was a century and a half ago, when it was fully described by Marsigli.* Each boat includes at least three men, who are provided with a cross, to whose equal arms are attached strong hempen nets. A large stone, which is placed in the centre of the apparatus, draws it rapidly to the bottom of the water, and not unfrequently to a depth of two or three hundred feet. While one of the

Marsigli, who was born at Bologna of a noble family, died in 1730. He was distinguished as a soldier and as a man of science. His principal work on natural history is entitled "A Physical Essay on the History of the Sea."

fishermen is alternately raising and lowering the machine, the remaining two or three men are engaged in gently rowing the boat, so as to sweep over a certain space; after a time the whole is drawn in, and the fragments of coral which have been torn up and retained by the meshes of the net, are carefully removed.

A rapid survey sufficed to show us that our zoological researches would not be extended by a prolonged sojourn at Stromboli; animal life seeming to shun these calcined rocks, which are as sterile under water as they are in the open air; but before quitting this district, we were anxious to visit the volcano. The receiver of customs, who had provided us with safe guides, agreed to accompany us, and each of us being provided with a stout stick or pole, we soon began the ascent. A very steep path in the midst of the moving sand led us, after three quarters of an hour's walking, beyond the zone of the vineyards. Here our difficulties increased; for the ground, which was more and more inclined, became less firm as we advanced, and was, moreover, covered with large thistles, whose sharp prickles penetrated at every step through our thin clothing. We very soon, however, passed beyond the limit of these prickly plants; for now every trace of vegetation disappeared, and we saw nothing around us but the old beds of lava, which in one place had been accumulated together like enormous scoriæ, whilst in another they were entirely concealed beneath the black and hot ashes which we could feel sliding from under our feet at every step we endeavoured to take in advance.

This part of our expedition was very arduous, and we were more than an hour in reaching the eastern summit of the island. Here we found a narrow ledge like the angle of a roof, the two sides of which sloped each in its own direction; the left-hand declivity led to the part of the mountain which we had just quitted, whilst the right-hand slope, whose inclination was precisely that which would be assumed by moving substances obeying the laws of gravity, presented a perfectly smooth surface, which was terminated by a rock, lying about 1500 feet below us, and overhanging a vertical precipice. We crossed rapidly over this edge, and reached the summit of the old cone, which is more than 600 feet above the present crater, which opens on its crumbled sides. As if to celebrate our arrival, the volcano saluted us by an eruption. We saw the abyss kindling at our feet, whilst a magnificent jet of fire rose towards us with a noise resembling the repeated discharge of artillery.

Standing immediately above the crater, and unable to advance far over this moving soil, we were impeded in our observations by the mountain itself; whilst we were moreover almost constantly surrounded by clouds impregnated with stifling gases. To avoid these inconveniences, we descended to a lateral ridge, where we were able at our leisure to contemplate the desolate scene displayed before our eyes. Three concentric ridges, of which the two outer ones are partially destroyed, encompass the volcanic crater. Behind us steep declivities stretched down to the cultivated regions, which we had found

it so arduous to traverse, but which appeared, when seen from our elevated position, to be a mere plain. To the left our eyes rested on the highest peak of the island, which was once a portion of the most ancient and the outermost of the three concentric ridges, and which was separated from us by a deep ravine. To the right was the small elevation from which we had just descended; whilst in front of us the ridge on which we were standing curved in a semicircle towards a mass of lava suspended over a precipice, and at the same time enclosed a steeply inclined mass of cinders and scoriæ abruptly cut by the edges of the abyss, into which the existing crater opens.

This crater encloses within its walls six distinct mouths. Two of these secondary craters eject that smoke, impregnated with hydrochloric and sulphurous acid gases, which is at all times being emitted from the summit of the mountain. The third mouth, which is situated to the right, also throws out a thick and whitish smoke, in the midst of which red fiery stones flash like sparks as they incessantly rise and fall in the midst of a strange noise, resembling the heavy surf driven on a storm-beaten coast, and making one involuntarily think of the mythical caves of the demons. To the left lie the three mouths which exhibit only intermittent eruptions; two of these evidently belong to the same focus, for they always kindle and become extinguished simultaneously. The third, whose eruptions are much less frequent than the others, is nearest to the spectator. The most formidable detonations proceed from this crater,

which, moreover, throws up the highest jets of burning cinders and rocks.

As we had arrived in broad daylight, we had been enabled thoroughly to examine all these rocks of lava, and at our leisure to contemplate the steep ridges, the declivities of ashes, and all that singular scene whose uniform blackness was only broken in a few places by masses of sombre red scoriæ; but the sun had now set, and the short twilight of these southern latitudes was rapidly giving place to night. In proportion as the light became extinguished in the sky, it seemed to revive within the depths of the abyss. The smoke assumed a redder tint, becoming gradually more and more fiery, the showers of sparks increased, while the concentrated light within the crater itself enabled us better to follow each varying phase of the eruption. The explosions of the two smaller mouths recurred every seven or eight minutes, whilst ten or twelve minutes intervened between the eruptions of the large crater. The phenomenon was always effected in the same manner; thus, for instance, at the moment when the volcano began to exhibit signs of activity, the smoke which issued from the openings to the right, rapidly assumed a bright and vivid red colour, while more and more quickly recurring detonations preceded every jet of burning matter. These jets were thrown up in diverging directions, and almost without any smoke, from one of the two sister-craters, whilst from the other they darted upwards, as if impelled by the current of violet-coloured vapour that escaped from the mountain with a loud whistling

sound. The principal crater ejected a broad and expanded jet of incandescent rocks and lava, which nearly reached the platform on which we were standing, and fell with a loud noise, one portion being carried into the sea, and the remainder thrown back into the abyss from whence it had been ejected, whilst the wind blew over us clouds of the black and fine sand and ashes.

The night had long since closed around us, and our guides were urgent that we should make the descent; we were therefore compelled to yield to their request, and prepare for our return; but before we made our final retreat, we waited to see another eruption, and this fortunately proved to be most magnificent. The three mouths were playing simultaneously, and reflecting the reddish brightness of the lava, whilst the triple enclosure of the crater revealed itself once more to our eyes. After we had sufficiently admired this grand spectacle, we took one of the paths to the right, which being entirely formed of fine sand, facilitated our return quite as much as it aggravated the difficulties of our ascent. Our guide had assured us that on this side of the mountain there was not a single stone to be met with, and on the strength of this assertion, M. Edwards and myself set off at full speed, and soon left our more circumspect companions far behind us.

There was something very singular in this descent. The blackness of the soil absorbed the faint rays of the stars, while the night was so dark that I could scarcely see the white jacket of our guide at three paces in front of me. Impelled by my own impetus,

and by the declivity of the mountain, I advanced without fatigue, but with no direct aim and as if I were moving in a dream, in the midst of thick darkness, over ground which slid away from my feet. In ten minutes' time, we had passed beyond the limits to which the ashes and cinders extended, and here it became necessary to proceed with the greatest caution, as we had literally to feel our way for the rest of the descent. Our hands were touching the edges of steep declivities which we could not see, and the extremities of rocks which we were obliged to descend step by step. At length, however, we reached the shore without accident, where in about half an hour we were joined by the rest of our party. Without loss of time, we at once returned to our boat in order that we might observe the volcano from the sea; the view, however, was not nearly so striking as on the mountain itself, the crater being too distant from the spectator. We may indeed distinguish the jet of burning matters which are thrown up from the volcano, but the scene has none of that magnificent grandeur which it possesses when it is viewed from the mountain top, where the incandescent smoke rises in eddying clouds round the old and half-crumbled cones which are illuminated by the temporary flashes of the eruptions.

This slight disappointment, however, did not make us regret our nocturnal expedition; for the sea, as if by way of atonement, exhibited to us in all its splendour the glorious phenomena of its phosphorescence. For more than an hour, the waters around us seemed to be kindled into a blaze of light, as if

they had borrowed some of the hidden fires of Stromboli. The waves as they broke along the rocky shore encircled it with a glowing band of light, whilst every projecting cliff was circled with a wreath of fire. Our boat seemed as if it were opening for itself a passage through some glowing and fused liquid, whilst in its wake it left a long track of light, each stroke of the oar brightening the bosom of the waves with a broad silver gleam. The water that was taken up in a bucket presented the appearance of molten lead, as we slowly poured it back into the sea. Everywhere over this brilliant surface of calm light, myriads of dazzling green sparks and globes of fire were flashing, quivering and dying amid the undulations of the waves, and these sparks and globes of fire were so many living beings — animals belonging to the Crustaceans, Annelids and Medusæ. At certain times of the year, and probably at the period in which the accomplishment of the reproductive functions requires a superabundant manifestation of vital activity, these microscopical beings acquire the property of emitting light at each muscular contraction; and hence every movement in these animalcules is made apparent by a luminous flash.

The numerous observations which I made on the coasts of Brittany and Normandy, led me long ago to this conclusion, which has been further confirmed by new researches. Professor Ehrenberg, on the other hand, is of opinion that some Annelids possess, like Glow-worms *, a special organ whose function is

* The name of Glow-worm has been given to different species,

to produce light. Fishermen are well aware of the fact that a substance exudes from the bodies of some Molluscs which shines in the dark like decayed wood or putrid fish, and in these animals the phenomenon no doubt depends on a slow combustion. Nevertheless, an observation made by MM. Audouin and Milne Edwards seems to throw some doubt on this explanation; for these naturalists saw the phosphorescent liquid of the Pholades flow in a stream along the bottom of a vessel filled with spirit, and combine into one mass, where it formed a luminous stratum without losing any of its intensity. It is evident, therefore, that phenomena of a very different nature have been confounded under the common

and even to different genera of the Coleoptera. Those which are met with in France, more particularly in the neighbourhood of Paris, belong to two species of the genus Lampyris; the commoner of the two is the *Lampyris splendidula*, the other is the *L. hemiptera*. In these two species the female alone possesses the faculty of producing light. Unprovided with wings, and unable to leave the tufts of grass or the thick bushes which conceal her, she would fail to be discovered by the male insect, if nature had not provided her with a species of torch, which she can light or extinguish almost at will. The luminous organ occupies the three last segments of the abdomen, and is formed by a tissue of a somewhat fatty appearance, in which we discover a large number of tracheæ. This abundance of vessels, destined to convey the air into the phosphorescent portion of the body, leads to the supposition that the production of light may here be due to a sort of slow combustion, analogous, for example, to that of phosphorus. The experiments of Macaire, and more recently still those of M. Matteucci, have placed the reality of this explanation beyond doubt. The light of the Lampyris is extinguished in all gases unable to support combustion, while it is rekindled in oxygen, and carbonic acid is evolved. Hence, in this respect, these insects present the same chemical relations as burning charcoal.

denomination of *phosphorescence*, and that this curious question is by no means settled.

After having passed the rest of the night at anchor opposite to Stromboli, we set sail the next morning for Messina. This passage of nearly sixty miles was not entirely lost as far as our researches were concerned; for Milne Edwards and myself had become such good sailors, that as long as the weather continued calm, we were under no apprehensions of sea-sickness. Therefore, while M. Blanchard was arranging his cases, and fixing and labelling the insects which he had found at Milazzo and on Stromboli, we were busy in dropping our bags and nets to arrest in its passage every living creature that chanced to come within reach of our snares. In this manner we procured various remarkable larvæ belonging to Annelids and Crustaceans, together with several curious specimens of the Medusidæ; amongst others, the Velella *, a lovely little zoophyte, which possesses more than one claim to our notice. Its dark blue umbrella, which is provided on its lower surface with numerous suckers, is strengthened above by cartilaginous plates, enclosing a certain quantity of air, whilst a layer of the same nature, which is placed vertically upon the others, crosses the back of the animal in an oblique direction. Supported on the surface of the water by means of the air with which they are

* The Velellas, which were placed by Cuvier among the ordinary Acalephæ, have in recent times been classed with the hydrostatic Acalephæ or Siphonophora, of which we have already spoken in the first volume. (See the Memoir of Vogt, entitled *Siphonophores de la Mer de Nice.*)

ballasted, and urged onwards by the wind which strikes their vertical plates like so many sails, the Velellas often float in large numbers on the waves. We did not, it is true, meet with any of these living flotillas, but we saw several isolated individuals. We also collected some specimens of the Ianthina, a charming little Gasteropodous Mollusc, whose body, enclosed in a pale violet-coloured shell, is suspended to a spongy mass looking like consolidated soap froth, which prevents the animal from sinking to the bottom. These various captures enabled us patiently to support the wearisomeness of our voyage, which at one time was interrupted by calms, and at another by contrary winds. At length, after a second night on the sea, which we passed within a mile and a half of the lighthouse of Messina *, we entered the narrow channel, which separates Sicily from Italy, and in another hour we were standing on the quay at the moment when the sun, rising behind the Calabrian

* Messina is one of the most ancient cities of Sicily. It is believed to have been founded about ten centuries before our era, when it bore the name of Zancle, and subsequently that of Messana. The position of Messina, its vicinity to the continent, and the beauty of its situation and excellence of its harbour, have made it play a considerable part in the history of Sicily. It has always been regarded as the key of the island, and from this very importance it has suffered greatly. Again and again taken and retaken, repeatedly destroyed, and as often rebuilt, it has resisted alike the attacks of man and the convulsions of nature. The earthquake of 1783, amongst others, destroyed it almost entirely, and hence it contains none of those ancient edifices which one might expect to meet with in a city whose origin dates back nearly three thousand years.

heights, was gilding the summits of the Pelores, whose chain of mountains stretches as far as the straits, and commands the town. To naturalists, who, like ourselves, had not had any society for nearly four months beyond that of their boat's crew, Messina possessed a special attraction. We even met with persons here to whom we could speak on scientific matters, and at the hotel of La Vittoria, we encountered the celebrated German traveller Rüppel, who, after two years' travelling in Abyssinia and on the borders of the Red Sea, had come to Sicily to study the fishes of the Mediterranean. While we remained at Messina, our labours were daily shared by several distinguished men, whose acquaintance we were fortunate enough to make during our stay; amongst these, we may mention M. Tardi, a young mathematician already known by several interesting publications; Dr. Cocco, a naturalist who struggles courageously against the indifference of an ignorant public and the bad will of a suspicious government; and Dr. Cupari, whose rare talents have led him to be called to the University of Pisa; and, thanks to this pleasant intercourse, our labours seemed at once more easy and more productive of valuable results. However, it was time soon to return to our wandering life, for ten days had sufficed to explore the harbour of Messina and the sand thrown up by the whirlpool of Charybdis. The *Santa Rosalia* was therefore again put to sea, and skirting along the rugged coast, which borders this portion of Sicily, we entered the little harbour of Jardini at the foot

of the mountains on which stands Taormine *, with its magnificent amphitheatre facing Mount Etna, whose black lava beds reached nearly to the point which we occupied. Here we resumed our labours with increased ardour, and feeling that the close of the season was now approaching, we directed our efforts rather to the completion of the studies which we had already begun than to the attempt of making new discoveries, and in this respect the Bay of Taormine was admirably adapted to our purpose. Indeed, notwithstanding the oppressive heat, which daily raised the thermometer to the height of 112° F.,

* On reaching Taormine from the south coast, the road follows the sinuosities of the sea-shore, skirting along the side of a tolerably well cultivated coast, till it reaches the point of Castel-Sciso, which forms the commencement of a bay, which is bounded by Mount Taurus. It was at the base of this little gulf, that the ancient city rose on different plateaux of the mountain. Owing to its difficulty of access, it was almost always the last place taken by the conquerors of Sicily. The Saracens did not definitely become masters of it until the year 961, and their possession of it retarded for a long time their final expulsion from the country by the Normans. The ancient Tauromenium, which was formerly one of the most splendid cities of ancient Sicily, is now a very unimportant place, but its situation is magnificent, and its ancient ruins, which date from various epochs, offer a variety of aspects, presenting a degree of incomparable beauty. Among its many splendid remains, there is none that can be compared to the amphitheatre. Elevated upon one of the heights, which command the plateau of Mount Taurus, and partly cut out of the rock, this edifice, by its situation, is one of the most picturesque that it is possible to imagine. Its form and its principal arrangement testify to its Greek origin, while Roman splendour is ostentatiously apparent in the traces of thorough re-construction which this theatre seems to have undergone under Augustus. It was adapted to hold from eleven to twelve thousand spectators.

we completed some of the labours which we had begun at Torre dell' Isola and the other stations which we had subsequently made the scene of our researches.

In the course of our various expeditions, Milne Edwards had completed his researches on the Acalephæ, and had terminated those observations on the circulation to which we have already referred, and which were subsequently destined to acquire a character of more general application from the elucidation afforded by the various collections of M. Valenciennes*, who enriched M. Edwards's Memoir with

* M. Valenciennes, who is a member of the Institute and a professor at the Jardin des Plantes, occupies in science a position which is very rarely attained, for he is accepted as the chief of a very important section of Zoology, even by those who are opposed to him on special points, and in the estimation of his colleagues he undoubtedly ranks as the first ichthyologist of the age. First as the pupil, and afterwards as the assistant and collaborateur of Cuvier, he commenced with him the work, entitled *Histoire Naturelle des Poissons*, the first two volumes of which were published in 1828. Six other volumes appeared before the death of Cuvier. In these first eight volumes, the parts contributed by M. Valenciennes are clearly defined by the signatures, which each of these two authors subscribed to his own work. The portions of the work which have appeared subsequently to that period are entirely due to M. Valenciennes. It is to be hoped that the difficulties which have so long retarded the completion of this great work, may soon be overcome.

Having been admitted from early youth to the intimate acquaintance of Cuvier and of Humboldt, and being consequently brought into immediate contact with the great founders of modern science, M. Valenciennes was not likely to limit his studies to the external forms of animals. Both in his great work, as well as in all his Memoirs, we find that the anatomical history is always conjoined to the external description of the animal. Several researches on the incubation of serpents, on the respiration of fishes, and on the minute structure of the tissues, &c., have moreover amply shown

many valuable remarks. Many curious facts, although possessed of less intrinsic value, were now added to these important results. But since the discovery of the method of descending to the bottom of the sea had enabled us to collect an abundant supply of the eggs of a great number of the Molluscs and Annelids, Milne Edwards had devoted his attention almost exclusively to the study of embryology.

Facts that relate to the development of living beings have at all times possessed extreme interest; and in our own day they have acquired an additional importance. There can scarcely be a more attractive spectacle presented to the true philosopher of nature

that this naturalist has comprehended and shares the physiological tendencies of our age.

Few men have rendered more signal services to the Museum of the Jardin des Plantes than M. Valenciennes. Independently of his labours while assistant to Cuvier, he has arranged two collections in the Museum, which were not represented before his time — viz., that of Intestinal Worms and that of existing Molluscs — and he has completely restored the collection of the Sponges, Echinoderms and Polyparies, while he has thoroughly remodelled the collection of Shells. Unfortunately the result of these very long and arduous labours, in which he has been ably seconded by his assistant M. Rousseau, can only be appreciated by those who have seen the full extent of his work; for, in consequence of want of space, the greater part of these objects cannot be exhibited to the general public. We ought to observe, however, that no one could be more liberal than M. Valenciennes in throwing open these collections for the inspection of those who are anxious to consult them for the purposes of science. Thus, for instance, M. Valenciennes unreservedly placed them, together with his own valuable notes, at the free disposal of MM. Milne Edwards and Jules Haime for their *Histoire des Polypiers*, of MM. Blanchard and Dujardin for their researches on the *Intestinal Worms*, and of M. Agassiz for his researches on *Echinodermata*.

than that of seeing life progressively manifested before his eyes in a body which had hitherto been apparently inert, and of watching a seed or an egg becoming transformed into a plant or an animal. The development of a germ realises in its phenomena of *evolution* the strangest metamorphoses that the imagination of poets had ever conceived, and by its phenomena of *epigenesis* we are enabled to take part as it were in creations of a still more incomprehensible character. All these mysteries, which are accomplished beneath the eye of the observer, were long regarded as marvellous but isolated facts, which were not investigated beyond the point necessary for their confirmation. At the present day, however, we turn to these facts for a solution of the highest problems of natural philosophy. And here the first question which presents itself is: Where are the termination and commencement of the vegetable and the animal kingdoms? What are the common attributes of the representatives of these two fundamental types of animated creation? What are the links that associate the offspring with its progenitors, constituting that ideal being which we term a *species*? Deeply interesting are questions such as these, which it is perhaps reserved for embryology to answer, now that naturalists have ceased to limit their studies to a few representatives of the highest types, and have extended their researches to the last links of the great series in the scale of being.

Among the most difficult problems that naturalists have proposed to themselves for solution, there is one, perhaps, which they will never definitely solve,

although they are incessantly approximating to the goal of their inquiries, somewhat in the same manner as in geometry, where certain curves only come in contact at an infinite distance with the straight line which forms their limit. The problem we refer to is that of the *natural method,* which we must be careful not to confound with *classification.*

By this natural method we are enabled to appreciate the different relations which connect with one another the elements of a group and the groups themselves; by classification we endeavour to represent these relations; but this latter method is necessarily inefficient. Being obliged in our books and delineations to describe and illustrate one by one the objects of our researches, we are enabled to represent each of them in immediate connexion with the object which precedes it and with that which follows it. From hence arise innumerable errors on the part of those, and they are unhappily too numerous, who, confounding these two very distinct things, mistake the means for the end and the classification for the method. Let us here refer to the words of a master, who after thirty years' labours and meditations appears to have foreseen and protested against the theories, which various false disciples have endeavoured to disseminate in his name. In that *Histoire des Poissons,* which the illustrious successor of Linnæus began, and which M. Valenciennes is at this moment completing, Cuvier thus expressed himself: "The further we advance in the study of nature, the more thoroughly shall we recognise the necessity of considering each being and each group

of beings independently, and in accordance with the character which they represent by their properties and organisation. We shall also see how necessary it is not to abstract any one of these relations, or any one of the links, which unite it either to the most nearly allied beings, or to others. If we once assume this point of view, the difficulties of the question will vanish, and everything will present itself simply and readily to the observation of the naturalist. Our systematic methods of classification only take into account the most proximate relations; they simply place a being between two other beings, and hence they are constantly at fault. The true natural method regards every organised being as if it were placed in the midst of all the others, it indicates all the radiations by which it is more or less closely connected with the meshes of that immense network which constitutes organised nature, and it is only by this method that we can attain to elevated, true, and grand ideas of nature worthy of herself and of the Creator. Indeed, ten or twenty links would often be insufficient to express these innumerable relations." *

What then is that Ariadne's clue, which, guiding the naturalist through the labyrinth, will enable him to see and comprehend, in the case of each of the beings which he is studying, these ten or twenty links of which Cuvier speaks? This great man

* Cuvier has often been reproached for having made *classification* the aim and object of zoology, but the passage which I have literally transcribed will show how unfounded is such an accusation. See the introduction to *l'Histoire Naturelle des Poissons*, tome 1er.

thought that they were to be sought exclusively in the organisation of adult animals, and more especially in the nervous system, and in this respect he departed from the principle that had been established by the genius of Jussieu, who sought in the embryo itself the primordial divisions of the vegetable kingdom. Zoology is only now beginning to enter upon that course of inquiry which has been so long and steadily pursued by botany, and it at length turns to embryology, which has already furnished it with more than one satisfactory reply both in respect to the present and the future.

Milne Edwards was one of the first to enter upon this new line of investigation*, and, as early as 1833, on presenting to the Academy a memoir relating to the changes of form experienced by different crustaceans, he showed that these metamorphoses always tend to impress upon the animal a more and more special character, and that they succeed one another in a determinate order, the most important being those which are the earliest manifested. Thus, for instance, in the Isopods, a family to which belongs the Woodlouse (Oniscus), with which every one is well acquainted, the young animal first presents the peculiar characters of the *family*, next it acquires those which determine the *genus*, and lastly those which enable us to distinguish the *species*. About the same time the celebrated German

* We here only speak of the application of Embryology to the improvement of the zoological method. We will postpone to a future occasion a consideration of its anatomical and physiological applications.

physiologist Baer * developed analogous principles, and since that date these researches have been considerably multiplied; and if we would here cite all the authors who have furnished proofs in support of this general fact, we should be compelled to give the names of almost all modern embryologists.

The most various researches, undertaken and concluded by men whose doctrines often differ in respect to many points, have nevertheless led to this one general and identical result, that every germ in the course of development is characterised from the first as a vegetable or animal. In animals the primordial type is distinguished from the very earliest time; next appear the characters essential to the secondary types; while, at a later stage, those of an inferior zoological importance make their appearance, and so on, until each part of the organism has acquired the proportions, forms and colours, which characterise the species.

We thus see that the different phases of develop-

* Baer, the author of a great number of works on zoology and physiology, has connected his name with one of the most curious discoveries of the present day. He was the first who saw and studied the ovum of the Mammalia, but in these observations, which were made in 1827, he compared it to the germinative vesicle, which Purkinje had discovered in the bird's egg. This conclusion led him to draw a fundamental distinction between the elements of reproduction in these two classes. It was not till 1834 that M. Coste demonstrated in the ovule of Baer the existence of a distinct germinative vesicle, and thus completed the discovery of the German physiologist, or rather he assigned to it its true value, by proving that the Mammalia, and Man himself, are propagated by true *ova* or eggs, which may be compared, in all respects, to those of birds.

ment correspond to more and more closely restricted zoological groups. The embryo acquires first the characters of the sub-division to which it belongs, then successively those of the class, family, tribe, genus, sub-genus, and species. Consequently two embryos which could not at first be distinguished in any way from one another, cease to resemble each other as they continue to grow, if they belong to remote groups, but they continue to be like one another for a longer time, if there exist greater affinities between the two species to which they appertain. Both follow one common road, if we may so express ourselves, until having reached a certain point they take divergent paths, and each assumes its own peculiar and distinctive characters.

If these facts be true, and if the consequences that we have deduced from them be correct, animals belonging to one fundamental group and to one and the same great sub-division of the animal kingdom will continue to be like one another during a certain period of their embryonic life; subsequently they will differ from one another, but they will at no period assume the characters essential to one of the other sub-divisions. The Articulata, for instance, can never assimilate to the Mollusca, nor the Vertebrata to the Radiata. The immense majority of facts which have been collected in reference to this subject, fully justify this conclusion. Nevertheless Loven *, a naturalist of distinguished merit, de-

* A Swedish naturalist who has published, among other works, some very important researches on the development of the Campanularias and Syncorynes, and who shares with Milne Edwards

scribed a larva which, according to his statement, had undergone the most singular metamorphoses, and which he believed to belong to a family of the Annelids, viz., the Nereids. These animals belong to the Articulata, but the larva was said to possess at one time the characters peculiar to Polypes, which constitute a section of the sub-division of the Radiata. In this case, facts and theory were completely at variance, and many persons in Milne Edwards's place would have treated with contempt an objection borrowed from a small worm who plays but an insignificant part in the animal scale; but from his familiarity with the study of the inferior animals this naturalist was led to adopt a different course, and from the very first day of our arrival in Sicily, the embryology of the Annelids constituted the special subject of his studies. From the very commencement of his researches, his own views were confirmed in all respects by the clearest and most definite facts, while the apparent exception that had been recorded by Loven disappeared when it was tested by an investigation fully as profound as that of the learned Swede. Milne Edwards ascertained, however, at the same time that Annelids are subjected, before they assume their definite form, to metamorphoses, which may, up to a certain point, be compared with those of insects.

We will take, by way of illustration, one of those sedentary species, which from their size and their

the honour of having discovered the gastro-vascular system of that group of Gasteropodous Molluscs, which I have proposed to designate under the name of the *Phlebenterata*. (See Vol. I. p. 348.)

accurately defined characters are admirably adapted for observation. We will follow through all the phases of its existence that large Terebella (*Terebella nebulosa*), whose body, which is of a brown colour spotted with red and white, sometimes measures from six to seven inches in length. On its sides are arranged small flattened protuberances, each of which carries a bundle of simple cirrhi, slightly curved, whilst below there is a row of hooked cirrhi, whose shape somewhat resembles the cock of a gun. On its back, near the head, are six pairs of ramified branchiæ, which being incessantly agitated by the blood, alternately present an amber tint or a deep coral red, according as the liquid leaves their branches or flows through their ultimate divisions. From the head escapes a tuft of a hundred to a hundred and fifty white extensile and contractile filaments, which are ever in motion. These are so many living cables, which the animal is able to extend in every direction to the distance of more than a foot, and which serve it in the place of arms. When fixed by their extremities, they enable the Terebella to raise itself along the most highly polished surfaces, as for instance, along the sides of a glass vessel; at other times, seizing from a distance grains of sand or fragments of shell, they bring them close to the Annelid, and arrange them round the body in the necessary order to enable the animal to take up these substances, and, by cementing them together with a viscid humour, to form a tube or gallery, often of very considerable length, within which it lives in security.

At the period of reproduction, the entire body of the female Terebella becomes filled with eggs, which by a mechanism which is not yet fully explained are all thrown off simultaneously, and which being retained by a sort of transparent jelly, form at the entrance of the tube a very nearly spherical mass of considerable size. Analogous phenomena occur in the male Terebella, but the fecundating liquid which is expelled by the latter diffuses itself freely in the water, and flowing in all directions conveys life to the germs, which are vivified by contact with it. Here, as in fishes, nature seems to trust to chance to secure the perpetuation of the species, yet nevertheless everything is so arranged, that this great end cannot fail to be fully accomplished. Among the numerous masses of eggs that we had collected in our glasses not a single one proved to be sterile, the strongest evidence that all must have been brought in contact with the vivifying liquid.

As soon as fecundation is accomplished, the egg of the Annelid becomes the seat of mysterious movements, analogous to those which MM. Prevost and Dumas * were the first to discover in the egg of the

* M. Dumas, a member of the Institute, and professor in the Faculty of Sciences and in the School of Medicine at Paris, owes the high position which he occupies entirely to his own exertions. He was scarcely apprenticed as an articled pupil to a pharmacien of Geneva, when he became known for the perfection of his preparations of iodine, and being soon afterwards associated with Prevost, he undertook, in conjunction with that learned physician, a series of researches on generation in general, on the embryology of the Batrachians, &c. Being attracted to Paris by that secret instinct which always draws to the largest theatre those who are

frog. The elements of the yolk or *Vitellus* group themselves in different manners, and finally present four distinct masses thrust into the centre of the egg by a whitish and granular substance. The process of development goes on rapidly, and we soon have before us a sort of spherical sac, whose interior is entirely occupied by the remainder of the Vitellus. No organ is as yet visible; we merely observe two small coloured spots, which indicate the place of the eyes. In this state of extreme imperfection, the young Terebella bursts through the membrane of the egg; at this period the body is rounded, and bristling in all parts with vibratile cilia. In this condition it resembles certain of the Infusoria, or perhaps still more those reproductive

best able to play their part in it, M. Dumas was appointed chemical demonstrator at the École Polytechnique, and the final direction of his studies was thus determined. We need scarcely here refer to the eminent part which he has played as a chemist, both independently, by his own researches, and through the numerous pupils who have accepted him as their leader, nor will it be necessary here to show how the ideas which he advocated have progressively replaced the electro-chemical theory of the illustrious Berzelius. But we ought to observe, that in the midst of his various successes and engagements, M. Dumas has never entirely forgotten the science which constituted the object of his early studies. For the last twelve or fifteen years his labours have been directed towards physiology, and especially to the application of chemistry to that science. By the influence which he has exerted in this direction, he must be considered as the actual leader of physiological chemistry, appearing in this respect, as the successor of Van Helmont, Sylvius, and Fourcroy. The present is not the place in which to discuss these doctrines, but I shall undoubtedly some day have occasion to revert to the subject, when I shall consider the labours and views of M. Dumas in relation to organised beings.

bodies in the lower plants, which M. Thuret has made known to us, and which for some hours present the characters of animality.

It is not possible, however, long to remain in doubt, for the embryo unfolds itself, becomes elongated, and throws out at its anterior part a minute smooth tubercle, bearing on its surface and on each side of it a round eye-point. From this moment its nature is definitely fixed. The observer cannot yet, it is true, recognise the class, family and genus to which the nascent being which he is observing belongs; but he may boldly affirm that when it has reached its perfect state, this being will be an articulate animal, for it already possesses all the fundamental characters of this great sub-division. Its body is composed of two symmetrical lateral halves, its dorsal and ventral surfaces may be clearly distinguished, its digestive canal stretches from the front to the posterior part of its body. Everything still seems to be homogeneous in this microscopical embryo; we discover no muscle, and yet it contracts in every direction, rolls itself into a ball, or flattens itself into a disc, and in these extreme movements it exhibits temporarily those forms which deceived the skilful Swedish naturalist.

At this epoch it is still impossible to recognise *à priori* if the embryo will become an Annelid, or if, stopping at the last series of the sub-division, it may belong to the groups of smooth worms, as, for instance, to the Nemertes. Our uncertainty is here of short duration, for rings appear upon the body and are rapidly multiplied, being always formed successively from

before backwards, each succeeding the last formed one. We see, therefore, that the embryo will be an articulate animal with its body divided into segments. In this state it reminds us by its external form of the leech, but cirrhi soon appear upon the sides. We now ask whether the young animal is allied to the earthworm or the Naïs*, which exhibit distinct rings

* Every one is familiar with the earthworm, which is known in zoology as the *Lumbricus*. The *Naïs* resembles it in many particulars, but instead of living exclusively in the humid earth, it lives in the water, at one time making for itself a passage or tunnel within the mud, and at another time attaching itself to the branches of aquatic plants. We will here mention a curious result connected with those great questions of general harmony which fall so essentially within the province of modern science. The *Lumbricus* and the *Naïs* had at all times been classed in the same group with Marine Annelids. But these first two genera have both sexes reunited in one individual, whilst my own observations, confirmed by a great number of zoologists, have demonstrated that in the Annelids the sexes are separate; hence it is necessary to place these animals in a different group. On the other hand, the resemblances which had caused them to be united with the Annelids are undeniable, and I have therefore been led to regard these resemblances as being indications not of *direct*, but of *collateral affinities*, or *analogies*. On examining the entire group of Worms from this point of view, we find that they may be separated into two series which I have designated as that of *Les Vers Monoïques*, and that of *Les Vers Dioïques*, of which I have given a table in the first note in the Appendix of Volume I.

Here a very remarkable general fact presents itself to our notice. All the Lumbricidæ comprising Naïs, inhabit fresh water, whilst all the Annelids, whether they belong to the wandering or the tubicolous groups, live in salt water. The former inhabit lakes, rivers, and brooks, whilst the latter are only found in the sea. The older authors have indeed spoken of Marine Naïdes and Marine Lumbricidæ, but in examining the species which are thus designated I have always found that they were either true Annelids or special genera allied to that class, like the Echiuri and the Polyophthalmia.

and are provided with cirrhi, but have no feet. This cannot be the case, for here are protuberances which appear upon the sides of each segment, and hence the embryo belongs to the group of Annelids, properly so called. It remains to be decided whether it will traverse its native sands under the form of a wandering Annelid, or whether it will be confined in a narrow tube, and lead the retired life of a tubicolous worm. This last doubt soon vanishes, for a small tubercle now appears in front of the head, which lengthens and begins to play the part assigned to the extensible filaments of which we have spoken. Other similar appendages soon appear by the side of the former, and from that moment the animal, being provided with the organs necessary to secure its relations with the external world, surrounds itself with a tube and begins to lead the life of a recluse.

We see, therefore, that at each phase of its development, the special nature of the *Terebella* becomes more distinctly characterised. We have recognised successively how the embryo belonged to the great division of the Articulata, then to that sub-division of it in which the body is divided into segments, then that it is a true Annelid, and finally that it is a tubicolous worm. Investigate it a little longer, and we shall be able to recognise its genus and its species. This is very much the same, as if being interested in

Thus the type of the Lumbricus and the type of the Annelid mutually replace one another according to the nature of the waters in which they live. These animals constitute corresponding terms to one another in nature as well as in our classifications; they are the *Geographical Analogues* of each other.

obtaining detailed information concerning some individual, we were first to learn that he was born in the old continent, next that he was a European, and then successively that he was a Frenchman and a Parisian, and that he lived in such a street, at such a number, and, lastly, that he bore such or such a name. From these and many other similar facts, we surely have the right to conclude that the different degrees of zoological relationship or affinity stand in direct connection with the duration of the primordial resemblances, exhibited by the embryos. Or to express the same idea differently, may we not admit that the apparent identity between two germs in the course of development will persist for a longer or shorter period according as these germs belong to animals, more or less resembling one another in their nature?

We have purposely employed the words *apparent identity*, for it is often difficult to ascertain whether the identity is real or only apparent. Two Terebellas of different species cannot be distinguished from one another until their development is complete. Does this imply that the germs were really identical up to this one definite epoch? We do not think so: and we concur with M. Chevreul in believing that the manifestation of differences under the influence of similar circumstances, in beings which hitherto might have been confounded, implies the existence of corresponding differences in an anterior state of organisation.* These differences

* *Considérations sur la Philosophie de l'Anatomie.* (Journal des Savants, 1840.)

do not the less exist, because they are inappreciable to our senses, and it is from the want of duly recognising this distinction, that men of high reputation have suffered themselves, more especially in Germany, to be led away by hazardous speculations, giving rise to abstract theories, which, although decorated with the name of the *philosophy of nature*, have for many years retarded the true progress of the natural sciences.

Whilst these different labours occupied M. Milne Edwards, his companions did not remain idle. M. Blanchard had ably fulfilled the task that had been entrusted to him by the directors of the Jardin des Plantes. More than 2000 species of insects, represented by at least 8000 individuals, were collected in his cases. About 500 of these species were wanting in the galleries of the museum, and fully 300 were altogether new to science; our companion therefore had given active proofs of his industry. But while he acquitted himself of the duties imposed upon him in his capacity of assistant naturalist and collector of specimens, M. Blanchard had by no means neglected labours of a higher order, and he might well look with pride and satisfaction at his collection of drawings and notes. Amongst other things, he had drawn up a highly interesting memoir on the nervous system of the Gasteropodous Molluscs; for, notwithstanding the magnificent labours of Cuvier, much still remained to be done in reference to these animals. Their nervous system especially was but little known. Cuvier had only distinguished a very small number

of *ganglia* or central masses, from whence are given off the branches which convey both sensibility and motion to every part of the body. M. Blanchard, however, discovered in this apparatus a most unexpected degree of complication, and he showed that in certain species these ganglia are very numerous, and that instead of the five or six hitherto observed, there existed nearly thirty of these masses.

This first memoir by M. Blanchard on the nervous system of the Invertebrata was the means of leading this naturalist to other highly important results. Endowed with a singular steadiness of hand, and an extreme clearness of sight which enabled him to distinguish, without the aid of instruments, the most delicate nervous filaments, he entered upon researches of a similar nature on the nervous system of insects — a class of investigations which present such extreme difficulty, that few naturalists have grappled with them. And fortunately his labours were recompensed by the discovery of a complete nervous system, especially distributed to the organs of circulation and respiration. This is a very remarkable example of the division of physiological labour, and at the same time a new proof that the more closely we examine these too much neglected beings, the more fully we shall recognise that they possess, in the eyes of the Creator, as high a degree of importance as animals of the largest size. The observations of Lyonnet on the goat-moth, and those of Strauss-Durckheim on the cockchafer *, have shown that the organism is fully

* M. Strauss-Durckheim, a French zoologist, was one of the first who fully comprehended the importance of Monographs. He

as complicated, if not more so, in insects, as in the largest animals, such as the elephant; and M. Blanchard, by adding many important facts to those which had been discovered by his predecessors, has further confirmed this general result.

Encouraged by his first success, M. Blanchard extended his investigations on the nervous system to those singular beings, whose existence and mode of propagation continued to within a few months of the present time (1854) to constitute one of the most curious problems of zoology.* We here refer to the *Helminthes*, or intestinal worms—animals which are sometimes developed in the very midst of the living tissues, in the muscular substance, in the brain, and in the ball of the eye, and therefore in parts which to all appearance are the best protected from any external influences. Lamarck and Cuvier almost absolutely denied them the possession of a nervous system. Many naturalists shared in this opinion, and if any isolated observation appeared to justify

accordingly resolved to give a history of the leading groups, by taking as a term of comparison one of the principal species, whose anatomy had been pursued to its utmost limits. It was thus that he chose the Cockchafer as the type of articulate animals, and Cuvier considered this work as the only one which could be compared with that of Lyonnet. In making his delicate preparations, M. Strauss-Durckheim had recourse to several ingenious inventions, and amongst others we owe to him the discovery of a very simple method of making extremely fine injection tubes. His labours have unhappily been suspended by premature infirmity, for, like Geoffroy and Savigny he has almost entirely lost his sight.

* I have elsewhere stated (see Vol. I. p. 345), that the researches of Van Beneden and Kuchenmeister have almost entirely solved the problem of the reproduction of the intestinal worms.

the philosophical doubts of the majority of inquirers, nothing authorised the admission in any general manner, that these animals were characterised by a well-defined nervous apparatus; nevertheless M. Blanchard has shown that such is the case, and he has confirmed or rectified by numerous examples the facts which had been obtained in reference to the *Distomata* and the *Nematoïdes** by Bojanus†, Mehlis‡, Laurer §, Cloquet ‖, &c. He has shown that the Tænias ¶ present a most singular arrangement, which

* The Distomata are a group of intestinal worms comprising the Liver-fluke, which is so common in sheep, together with all the worms which are allied to that form. The group of the Nematoïdes is composed of the Ascarides, and all the genera which are allied to that type.

† Bojanus, who is one of the most distinguished anatomists of Germany, commenced in 1817 a series of anatomical observations on intestinal worms, which had before that time been studied only in reference to their external characters. He was the first to discover the Sporocysts, and to recognise the nature of the Cercareæ. We moreover owe to him several important works, amongst others a magnificent anatomical memoir on the European Tortoise.

‡ Mehlis was one of the first who noticed the nervous system of the Trematoda, in an anatomical description of the *Distoma hepaticum* and *D. lanceolatum*.

§ We owe to Laurer, amongst other works, some highly interesting researches on the anatomy of the Amphistoma.

‖ M. Cloquet has published, on the anatomy of the *Ascaris lumbricoides*, a memoir which has long been the best on the subject.

¶ The Tænia, which is vulgarly regarded as a solitary worm, does not by any means merit this appellation, for even in man several of these animals are often simultaneously present, and certain species occur in large numbers, more especially in fishes, many individuals being present in the same intestinal tube. We would here remark that in accordance with Van Beneden's view each Tænia is not an *individual*, but an *aggregation of many individuals*, which being at first united, become successively isolated,

constitutes another exceptional character in these already remarkable worms. All these facts, illustrated and confirmed by extremely delicate preparations, were submitted to the most competent judges, and the consequences deduced from them are highly important. They have led us to recognise the fact that very different animals have hitherto been confounded under one common denomination, and they have enabled us to appreciate the relations which connect these different types with already established groups, and finally they have removed an extremely numerous class from the animals which we regard as altogether devoid of a nervous system.

This is a very important result. The nervous system, says the illustrious author of the *Règne Animal*, represents, so to speak, the whole animal. We are far from accepting this doctrine unconditionally, but at the same time we cannot deny extreme importance to that system, which appears in the highest living beings to distribute life to every part of the organism.* The absence of this system is in

and lead an independent life as soon as their organisation is completed. We ought to add that these ideas, startling as they may appear, very probably express the truth.

* It is well known that in order to remove from a limb every trace of sensibility and motion, it is sufficient to cut, or simply to compress, the nerve which supplies it. The limb itself, however, does not die, inasmuch as the circulation and the nutrition are carried on very nearly in the same way as before the operation, and we might, therefore, be led to believe that the words of the text convey a very great exaggeration, but it is well known that there exist in the superior animals, and even amongst a certain number

itself sufficient to set aside in a distinct category, as it were, all those animals in which such a deficiency is definitely established, but the number of these animals is very limited. In proportion as we carefully study the most apparently degraded animals, we discover more and more traces of the existence of this system in the greater number of them. Cuvier had admitted its presence in the animals which were classed by him in his first three divisions of the animal kingdom, but he denied its existence, or regarded it as present in mere traces, in all the Radiata. It is now some years since MM. Tiedemann *,

of the Invertebrata, two distinct nervous systems. One of these systems has for its centre the brain and the spinal cord, and the nerves which issue from it are called *nerves of animal life*, which exclusively preside over the functions of sensibility and voluntary motion. The other nervous system, which is called the *system of the great sympathetic*, has for its centres ganglia, varying in number and size, which in all the Vertebrata are situated in the abdomen. The nerves which emanate from hence are called the *nerves of vegetative life*, and they preside over the involuntary movements which occur throughout the whole body, and do not communicate any sensibility to the organs. These nerves, which are very numerous, and much ramified, everywhere accompany the vessels, and it is probable that it is under their influence that the phenomena of nutrition are accomplished.

* Professor Tiedemann, who is a foreign associate of the Institute, is one of the most illustrious representatives of science in Germany. He for a long time occupied a Professor's chair at Heidelberg, where his reputation attracted a crowd of students from all countries, and he now lives in retirement at Frankfort. We owe to him a large number of anatomical and physiological works, among which we shall more especially mention his different Monographs on the Brain of Man, the Apes, and certain other Mammals, his treatises on Zoology and Physiology, his Anatomy of the Echinodermata, which received the prize awarded by the Institute, &c.

Costa *, and Krohn † have demonstrated its existence in the Echinoderms to which belong the star-fishes, while MM. Ehrenberg, Grant, Milne Edwards and Agassiz have described it in the Acalephæ, while we ourselves have discovered it in the Nemertes and the Planarias, animals which are very nearly allied to certain intestinal worms, although they live in water. Fully half of the Radiata and all the Worms, therefore, possess nerves as distinct as the higher animals.

A most interesting question is connected with that of the existence or absence of the nervous system. What relations exist between the external world and these lowest representatives of the animal creation? Do Annelids, Star-fishes, and Medusæ possess the senses of sight and hearing? Lamarck, influenced by theoretical ideas, denied them all sensation, and designated the majority of the inferior animals by the denomination of *animaux apathiques*, and, without being equally explicit, Cuvier seems to

* Dr. Costa, a physician and naturalist at Naples, has published a great number of very interesting memoirs, which bear principally upon the marine animals of his native country. He was one of the first who studied with care the anatomy of the Amphioxus, a very remarkable fish, to which I have referred in a subsequent part of the present chapter.

† The naturalist Krohn has also specially devoted his attention to the marine animals. Amongst other works, we are indebted to him for a very interesting memoir on the mode of reproduction of the Salpæ, in which he has confirmed, and at the same time more fully developed, the facts announced by Chamisso, which had long been treated as fabulous. He has shown that the mode of generation of these Molluscs, compels us to include them among those animals in which Steenstrup's theory of alternate generations is exhibited. See Vol. I. p. 219.

have inclined to the same view, which is maintained even at the present day by some eminent naturalists.

Experience and observation appear to us to be opposed to these theories; for not only do a large number of the inferior animals possess sensorial organs by which they must consequently perceive sensations, but these organs are even in some cases much more multiplied than in Mammals or Birds. Thus for instance several of them realise the fable of Argus, or the strange conception of Fourier in relation to the fifth member which is to complete the human being, when the globe will be covered with *phalansteries*. Certain Star-fishes have a well characterised eye at the extremity of each of their rays, while the Nemertes and the Planarias are often provided on the lower and upper surface of their heads with fifty or sixty, and sometimes even a larger number of distinct eyes. Ehrenberg has made known to us a small Annelid, which is furnished with two eyes in its head, and two others at the extremity of its tail; and I found both in our seas of Brittany and during my stay in Sicily, three totally distinct species, presenting the same peculiarity. Yet the tufts of Corallina at Favignana and Milazzo nourished thousands of little worms, which are even more remarkable in this respect. These worms, which I have named *Polyophthalmia*, and to which I shall have occasion presently to revert, are provided in front with three double or triple eyes, while a series of the same organs are placed along the entire length of the body, passing from the head to the tail.*

* See Chapter VIII. on Guettary.

We see, therefore, how much we have advanced since the period when Réaumur called the Medusæ masses of *living jelly*, and when Cuvier believed with other naturalists in the existence of *Parenchymatous Worms*. In proportion as zoologists have more thoroughly investigated the mysteries of the inferior world, organisation seems to have grown more complicated, and to have assumed the most unexpected forms. Let us beware, however, of falling into an opposite extreme. After having admitted without sufficient proof, and by a sort of *à priori* reasoning, the organic simplicity of the lower animals, we must not conclude from a few already known facts, that they all present an equal degree of complication. At the lowest point of the zoological scale, there exist beings in which all the vital acts are accomplished, simultaneously and in the same manner, over all portions of the body, and whose organs appear to be fused together into one homogeneous structure. I will here give a few examples by way of illustration.

In the living sponge, a sort of semi-fluid varnish covers with a thin stratum that horny and more or less solid skeleton, which is so familiar to all of us. This varnish is the actual animal, the structure which we commonly term sponge, being, in fact, its skeleton. The Amœba, which is still more simple, appears to be nothing more than a drop of this living varnish endowed with locomotion, but not having even a determinate form. The eye when aided by the microscope may see these animals flow together into a mass, as drops of oil would flow over the slide, while they present the most diversified and irregular forms.

Finally, M. Dujardin has shown us that the Rhizopods are animals covered with a shell, but whose body is without any definite organisation. A Gromia and a Milliola, before they climb up the polished side of a glass vessel, form for themselves on the instant, and at the cost of the substance which composes them, a sort of foot, which stretches out, and becoming elongated, affords them a point of support; as soon as they no longer need this assistance, this temporary organ returns into the common mass, and becomes confounded with it just in the same manner as a thread of viscid matter returns to the substance from which it had been drawn out. Between these extreme points of the animal scale and the creatures of which we have just now spoken, there no doubt exist many intermediate forms; for, as Linnæus has said, nature does not make any sudden bounds, and always proceeds by insensible gradations. Here, perhaps, more than elsewhere, experience and observation ought to precede all theoretical conceptions.

It is, moreover, by following these two infallible guides that modern zoology has arrived at a result which seems to be the counterpart of those we have indicated. At the same time that it discovered in these last animal series (the worms) a most unexpected organic complication, it also recognised the fact, that the superior groups themselves comprise degraded species, which appear to have lost almost all the essential characters of their fundamental type; and there are certain points of view from which we are justified in asserting that there exist inferior mammals, birds and reptiles. This proposition is most abso-

lutely true for the class of the Fishes; for the group of the Myxinoides, Lampreys, and more especially the Amphioxus, can leave no doubt on this subject.

The Amphioxus is a small fish which lives in the sands of the sea, where it conceals itself and moves about with incredible rapidity. Its body, which is perfectly transparent, terminates in a point at both extremities, a circumstance from which it has derived its name. The Amphioxus has been found on the coasts of Cornwall, in the Baltic, at Naples, and at Messina, where I caught a great number at the distance of a few yards from the whirlpool of Charybdis. It has been investigated successively by Goodsir* in Great Britain, by Costa in Italy, by Retzius, Rathke†, and more especially by Müller,

* John Goodsir, one of the most distinguished physiologists of Great Britain, is Professor of Anatomy in the University of Edinburgh, and has published several important memoirs. He was one of the first who announced, in relation to the mechanism of secretions, a doctrine which seems to be more and more thoroughly confirmed by facts. According to this distinguished physiologist, the secreted fluids do not exude directly from the membranes which yield them, but they first accumulate in the epithelial cells, which always cover the secreting surfaces. These cells are, therefore, the fundamental element of every secreting system. The facts discovered by Goodsir in reference to the digestion of fatty matters, and the conclusions which he has deduced from them, afford the most probable explanation that has been offered in reference to this very obscure point, notwithstanding the many attempts that have been made to elucidate it.

† Rathke is one of the most distinguished anatomists and naturalists of Germany, and his researches have been extended to almost every department of the animal kingdom. He has specially occupied himself with embryology, and amongst other works we owe to him some highly interesting researches on the formation of

in Germany. I have myself made this fish the subject of a most careful investigation, and at the present day we may consider its organisation as perfectly known. Yet while we have no difficulty in asserting most definitely that it belongs neither to the Mollusca, the Articulata, nor the Radiata, it scarcely merits the name of a Vertebrate. It has hitherto been admitted that the essential characters of this sub-division of the animal kingdom are the presence of a vertebral column, a brain, a heart and red blood, yet the Amphioxus possesses neither heart nor brain, properly so called, nor any distinct vertebral column, and its blood is entirely colourless. The impulse necessary to make the nutrient fluid pass through the circulatory circle is communicated to it by large vascular trunks. The blood resembles that of the Molluscs. The vertebral column is represented by a cartilaginous stem, entirely composed of cells, and extending from the head to the tail. The brain, which is not protected by the slightest appearance of a cranium, is only distinguished from the spinal cord by the direction of the nerves which issue from it. The eye is entirely enclosed in the interior of the tissues, but owing to their perfect transparency, it is probable that the functions of the organ of sight are not the less perfectly accomplished. This diaphanous character of the Amphioxus enables us, moreover, to ascertain that it possesses a mouth, which belongs rather to the Mollus-

the venous system, and on the manner in which the circulation of the adult gradually succeeds that of the fœtus. His *Embryology of the Cray Fish—Astacus fluviatilis* — is also a very remarkable work.

than the Fish, together with a circulating apparatus and a mode of digestion which remind us of similar organs in the Annelids, &c.

The attentive study of the Amphioxus has led to consequences of the highest importance both to zoology and physiology. Confirming in this respect the embryological results to which we have already referred, it shows us in this degradation of an animal, a permanent condition which recalls in certain respects the transitory condition of the most perfect animals belonging to the same type. Thus during the first periods of its development, the embryo of an ordinary fish, as for instance a Salmon, possesses peculiarities of organisation which remind us of those which we observe in the Amphioxus, but whilst these peculiarities are persistent throughout the whole life of the latter animal, they are soon effaced in the young salmon to give place to other definite characters. The embryology of the Annelids exhibits precisely similar facts; thus, for instance, in the early period of its existence, the larva of the Terebella closely resembles a Nemertes, and thus the results which have been furnished by the anatomy and embryology of Fishes and Annelids are perfectly in accordance with one another, notwithstanding the great distance which separates these two groups.*

By the very fact of its degradation, the Amphioxus departs from the Vertebrata to approximate

* Let us once more remind our readers that we speak here of *partial resemblances* and not of *identity*. A young Terebella is at no time an adult Nemertes, nor can a Salmon ever have been an Amphioxus.

more nearly to the lower divisions. Nevertheless the new affinities which are thus manifested do not connect it with those animals which occupy the highest places in these divisions. The Amphioxus by its organic structure never reminds us of the Cephalopods, or the Insects, or the Crustaceans, but it rather approximates to the Acephalous Molluscs, as, for instance, the Oyster, and to the Annelids; or, in other words, to the lowest representatives of the Molluscous or Articulate type.

Here, also, we find a manifest accordance between the results furnished by anatomy, and those which have been obtained from embryology. All germs resemble one another in the first period of their development, and they successively differ from each other in proportion to the advanced condition of their development, and consequently the beings which are evolved from these germs deviate from one another, in proportion to the degree in which they may be considered as representatives of their type. Consequently, also, the series resulting from these successive phases of development will be widely separated at their summits, but will approximate at their bases; and hence the relations borne by one series to another will be exhibited by the inferior but not by the superior animals.

In order to elucidate the more abstract features of the preceding ideas we shall have recourse to a homely comparison, which will easily be understood. Thus, for instance, we may represent the course pursued by the germs in the process of their development, as a high road covered with travellers. From this highway, which at first gives off no branches,

numerous roads after a time turn off to the right and left, diverging more and more from the central route. It is evident that those travellers who have entered upon these branch roads will deviate more and more from one another, in proportion as they advance. Here, then, in those who have reached the greatest distance from the general starting-point, we have a representation, in some measure, of the *superior animals;* whilst those who have only advanced a short distance from the main road, represent the *inferior animals.* The Salmon, to which we lately referred, the Cephalopods, the Insects, and Crustaceans correspond to the active travellers, and these manifest scarcely any points of resemblance to one another; while the Amphioxus and the Annelids correspond to the sluggish pedestrians, and amongst these we discover many points in common. In the same manner the two sub-kingdoms of the Vertebrata and the Invertebrata, which appear very dissimilar to one another when they are studied in their *higher* representatives, are very nearly brought into contact through these lower species, which may be regarded as *degraded* representatives.

We see how thoroughly in the Amphioxus everything appears to have been created as if for the purpose of affording the most complete refutation of those doctrines which have been advanced by naturalists, who, either through adherence to an antiquated science, or perhaps from the fear of incurring labour and fatigue, look with contempt upon the study of the lower animals, and rejecting the consequences which may be deduced from it, appeal

solely and incessantly to the Vertebrata. In the presence of the facts which this fish has taught us they may, perhaps, be more ready in future to admit the value of observations made in reference to animals so low in the scale of being as worms and zoophytes. Unless we actually deny the evidence of facts, we are compelled at the present day to admit that the representatives of the same type often differ very widely from one another, and that their organisation may present very different degrees of perfection and degradation. We must, moreover, here remember what are the facts which anatomy, in accordance with embryology, has taught us in reference to the existence of *distinct* fundamental types, which are modified in a thousand different ways to engender secondary and tertiary types *; for by a consideration of these facts we shall find that those systematic conceptions will speedily vanish which have been the means of giving at once so abnormal and false an idea of animated nature. Living beings will then no longer appear to us to be circumscribed within narrow series, which to whatever extent we may suppose them to be multiplied, will still invariably possess the inconvenience of reminding us of a straight line. The surface of our globe, like the immensity of the heavens, exhibits to us the creative power under a very different aspect; for we see it giving development to plants and animals in the same manner as it has produced the stars, distributing them into natural groups as it has reunited the

* See Chapter II. in Volume I. on the Archipelago of Bréhat.

different constellations, and finally binding together their thousand families by simple and multiplied links, in the same manner as it has rendered the worlds which people space dependent one upon the other.

The doctrines that we here advocate, received, some years since, a brilliant confirmation, which utterly excludes all doubt. Palæontology, that science which dates from Cuvier as its founder, but whose progress has been at once sure and rapid, has arrived by an independent course of investigation at absolutely similar results, deduced from the study of the order of succession of animals from the most ancient geological periods to our own day.

In truth, life has not glided along the surface of the globe by gradual and, as it were, concealed steps, by the intervention of beings, which at first were of the simplest structure, and gradually became more perfected, until they, in their turn, gave birth to still more perfect animals. The animal kingdom does not present one sole and progressive mode of development, as has been conjectured by the naturalists whose views we oppose. On the contrary, from the very beginning, we find that there must have been simultaneously present the four fundamental groups which, even at the present day, include the entire mass of created animals; for we find that the Vertebrata, Articulata, Mollusca, and Radiata, are buried side by side in the ancient fossil beds of the earlier world.

Even more than this, the three inferior sub-divisions possessed at that remote period representatives of almost all existing classes; and if it is otherwise

in respect to the Vertebrata — if Reptiles, Birds, and Mammals are wanting in these primitive faunas — a simple explanation of their absence would be furnished on the supposition of the external conditions being incompatible with their mode of life.

Moreover, in proportion as we rise to the more modern geological strata, we find these types modified; in some cases making a gradual advance towards perfection, up to the appearance of Man upon the globe, much in the same manner as we observed the progressive advancement of the young Terebella as it passed through each successive phase of its existence; while at another time the most perfect species seem lost, remaining to us only in their inferior forms, and thus giving rise to *recurrent series*, as we still see at the present day in certain animals, as, for instance, in the Lernea, which seems to retrograde by the very progress of its development.*

* The Lerneas are Crustaceans, which are extremely curious, on account of the metamorphoses which they undergo, the result of which, more especially in the females, is to induce a progressive degradation. These animals in their early age bear a considerable degree of resemblance to the Cyclops, a small Crustacean which occurs in great abundance in our fresh waters. They are at this period provided with a well-characterised frontal eye, whilst their natatory legs enable them to swim freely; but after having undergone several moults, they finally affix themselves upon another animal, at whose expense they subsist for the rest of their lives. The females attach themselves by some means to the body of this animal, whilst the males have their bodies attached to those of the females. The eyes and the limbs become gradually atrophied and disappear, while the different portions of the mouth become converted into a simple sucker. The changes experienced by the males are less marked, but the females become so completely degraded, that their nature was

Is there not something almost marvellous in this accordance? M. Agassiz* in his great work on the Fossil Fishes and Echinoderms, has especially in-

for a long time misunderstood, and Cuvier placed them amongst the intestinal worms.

* M. Agassiz, a corresponding member of the Institute, is a native of Switzerland. This naturalist has followed, with the greatest ardour, the paths of inquiry first opened by Cuvier, and it may be said that he has done for Fossil Fishes what the founder of Palæontology had done for the Mammalia, and hence his work on this subject will always be regarded as a standard authority in this department of science. M. Agassiz has, moreover, not limited himself to extinct species, but he has undertaken a great work on the Fishes of Europe, in which their anatomy and embryology occupy a considerable place. His palæontological studies have extended to the Echinodermata, and he has published, in relation to this subject, the extremely important memoir to which I have alluded in the text, *Resumé d'un Travail d'ensemble sur l'Organisation, la Classification, et le Développement progressif des Echinodermes dans la Série des Terrains.*

Led by the direction of his zoological studies to devote his attention to geology, M. Agassiz has advanced certain views in relation to the former extension of the glaciers, and the actions which they have exerted on the earth's crust; and these views, which were at first much opposed, now find many supporters. In order to confirm these statements by prolonged observations, M. Agassiz spent several successive summers on the most elevated parts of the Swiss Alps. With a view of completing these great works, M. Agassiz collected around him a band of eminent collaborateurs; amongst whom we may instance Professor Vogt, who contributed the embryological details in relation to the salmon in the volume on the Salmonidæ; Valentin, to whom we owe a very detailed anatomical monograph on the genus Echinus; and M. Desor, who has published a volume on the History of the Glaciers. M. Agassiz, who has been residing for several years in the United States, appears recently to have given a somewhat different direction to his studies; for he now devotes himself more especially to the study of the inferior animals, and in his anatomical researches on the Medusæ, he has discovered some very curious and highly important facts.

sisted upon these important considerations; nor has he scrupled to express in the following terms the consequences to which he was led by the result of his remarkable investigations. "The most natural zoological arrangement is the most general expression of geological order, and *vice versâ*, the order of succession of beings is the most certain indication of true natural affinities." In glancing in the preceding pages at some of the leading problems which zoologists of the present day are endeavouring to solve, we have expounded the doctrines of that physiological school to which we are proud to belong. In order to arrive at the solution of these problems, we have successively interrogated the anatomy of adult animals, embryological phenomena, and geological facts, and everywhere the reply has been one and the same. We may, therefore, confidently assert that the past and the present of our globe agree in sanctioning the fundamental ideas which lead us to the ultimate aim of all our inquiries—truth.

CHAP. VI.

THE COASTS OF SICILY.

ETNA.

Aspect and nature of the coasts from Giardini to Catania.—Catania; its harbour; its soil. — Etna. — Excursion to the volcano. — Nicolosi, the Casa Gemellaro; a night passed at the foot of the cone; the great crater; the crater of 1843. — Eruption of 1669; its traces as far as the town of Catania. — Elie de Beaumont's theory of Etna.— Observations made in the crater of Vesuvius.— Examples of the slight degree of solidity of the earth's crust. — Approximate calculation of volcanic forces.

SINCE our departure from Milazzo we had scarcely lost sight of the summit of Mount Etna, which was still smoking from the eruption of 1843. At Giardini we had obtained a view of the whole eastern side of the volcano, and here we saw the first bed of lava, the same which, 396 years before the Christian era*, was poured forth for a distance of nearly twenty miles from the crater, where it formed Point Schiso. We had often during the night watched the smoke which, escaping from the cone, reflected the reddish tint of the subterranean fires over all the neighbouring district; and often, too, a hollow rumbling sound,

* *Historical and Topographical Map of the Eruptions of Etna from the Era of the Sicani to the Present Time* (1824), by Joseph Gemellaro. This map is accompanied with a description in English and Italian.

but one that indicated inconceivable power, had fallen upon our ears either as a threat or a distant warning. As we skirted along the coast, which stretches for thirty miles between Taormine and Catania, we had everywhere recognised the action of volcanic forces; indeed, the whole of this coast, the rocks, mud, and sands, all owe their origin to the volcano. At every point the tufa of Etna is poured down into the sea, and is in all cases the result of eruptions which belong to the present geological period. A few beds of recent lava-streams also extend to the shore, and contrast by their black colour with the greyish tinge of the rest of the rock. Occasionally, too, these beds are superposed one upon another, as at Aci Reale, where the Scalazza is formed of seven distinct strata. Sometimes, also, eruptive rocks, whose origin goes back to the most remote geological ages, attracted our attention. The basaltic rocks of Cape Mulini, those of Castello d'Aci, of Fariglioni, and the Cyclopean islands, attest that in all ages this part of Sicily has been the theatre of the most formidable phenomena. Catania is, indeed, worthy of being the capital of a district that has been so fatally endowed; for, although it is separated from the great crater which is the centre of action of the subterranean fires, by a distance of nearly twenty-five miles as the crow flies, this town appears to be a direct product of the volcano. Enclosed within four lava beds of different ages, the materials for its houses and the pavement for its streets have been alike derived from this source; while it is only through the lava that the inhabitants

can reach the springs that supply them with water. The liquid fire has filled up its harbours, consumed its gardens, broken down its walls, and buried entire districts. Earthquakes, moreover, have destroyed what the lava had spared, and yet Catania has ever risen from the midst of her ruins, and after each new destruction has laid down wider streets, erected loftier palaces, and founded more splendid convents and churches. Yet she has not been able wholly to efface the traces of these catastrophes; and standing upon this soil, which has been so often upheaved, we everywhere found ample materials on which to begin those geological observations which, for a few days, were to supersede our ordinary zoological studies.

The little inlet of the sea which at the present day forms the harbour of Catania, bears no resemblance to that magnificent port which was celebrated by the poets of antiquity, who inform us that it reached more than three miles inland, penetrating to the very hills of Licatia, and everywhere securing to ships a safe anchorage, protected by an island.* The harbour in which Ulysses found

* "*Portus ab accessu ventorum immotus et ingens*
Ipse, sed horrificis juxta tonat Ætna ruinis."

VIRGIL.

We still daily meet with proofs of the existence of this ancient strand. In the eastern portions of Catania the wells traverse a thick stratum of lava until they reach a bed of clay or sand, which is occasionally intermixed with boulders and rounded pebbles; and here may be found a large number of shells, belonging to the same Molluscs which in the present day live within the harbour and along the neighbouring coasts. Fragments of wood have also been found in the same locality.

shelter has ceased to exist for many centuries. A hundred and twenty-four years before our era, a current of lava, bursting forth about six miles from the town, inundated the whole country lying to the east of Catania, blocked up the harbour, and passing over the banks changed the strand, which was once so easy and safe of access, into an unapproachable rocky height. Fifteen hundred years afterwards—namely, in 1381—another stream followed nearly the same direction, destroying the rich plantations of olive trees which had shot up on the old lava, and terminating its havoc by almost blocking up the little harbour of Ognina at about three miles' distance from Catania; while two other streams, very nearly parallel to the preceding one, enclosed the town to the west and north. One of these streams is referred back to the year 527 before our era; but this stream is of inconsiderable extent, and terminates within the harbour. The other stream dates no further back than the year 1669, an epoch which is well known to every Sicilian, and which recalls one of the most formidable eruptions of which we have any record. After having broken down a large extent of wall, it penetrated into the town, throwing into the very midst of the most populous districts vast masses of lava, which are worked in the present day as quarries.

Catania is situated at the southern extremity of the mountain side in whose centre lies the cone of the crater, and which almost entirely occupies a vast and nearly circular plain, bordered to the east by the sea, and to the south by the plain of Catania,

and to the west and north by high mountains of sandstone and calcareous rocks. A spur of this latter chain advances towards Etna, where it is soon lost beneath the volcanic tufa. From this point two small streams proceed—the Onobola and the Simete—which encircle the base of the mountain, marking almost exactly its limits, and transforming this burning focus into a veritable isthmus.

Isolated in the midst of its well-defined domain, Mount Etna rises in a pyramidal form to a height of nearly 11,000 feet *, and measures at its base from thirty to forty miles in diameter. This vast extent of surface, and the facility with which the eye can embrace every part of the mountain range, give to Etna a very different aspect from that which one might have expected. There is nothing menacing or abrupt in its appearance; and as the eye follows its broad and finely developed outline, which seems to rise in gentle slopes to the culminat-

* The absolute height of Etna varies with that of the cone which terminates it, and as the latter is modified by every eruption, new measurements are frequently required. Two distinguished Englishmen have obtained, by very different methods, results differing only by one unit, for the elevation of the highest summit before 1835. Admiral Smyth obtained his result by trigonometrical operations, according to which, the height of the mountain was 10,874 feet. Sir John Herschel by the use of barometrical observations obtained 10,872½ feet. We see therefore that the mean of these two results would be about 10,873 feet; but the summit which yielded these results no longer exists, and it would appear that the actual height scarcely equals that of another point of the crater, which was found by the same observers to be forty-three feet lower than the former. The height of Etna at the time of our ascent must therefore have been about 10,830 feet.

ing point, one is led to ask if this can in truth be the outline of that Etna which Pindar called the column of the heavens. We are apt, on looking at the mountain, to regard the narratives of preceding travellers as fabulous; we flatter ourselves that we can attain without fatigue the summit, which appears to be so slightly elevated above the horizon; and nothing short of actual experience can rectify this error.*

The declivities of which we have spoken are moreover variable, and the contour resulting from them consequently presents interruptions which may be easily perceived even by the naked eye. M. Elie de Beaumont† was the first to direct the attention of geologists to this important fact in connection with the formation of Mount Etna. The outline of the volcano forms an irregular circle of considerably more than 100 miles in extent, a more or less prominent range of heights separating it at

* The actual angle of inclination almost always differs considerably from the estimate that is formed of it, even by a practised eye. We always exaggerate the inclination of the slopes which we have to ascend. M. de Beaumont has made this very apparent in his memoir, by means of a table containing a large number of the exact measurements of different inclines. We shall here quote only a few examples, in order to afford the reader some idea of these results. The street of the Montagne-Sainte-Geneviève, which is perhaps the steepest in all Paris, has nowhere an incline of more than six degrees; and roads which have an inclination of ten degrees and a half are impracticable for carts. Loaded mules cannot ascend an incline of more than twenty-nine degrees. Sheep cannot reach grass that grows on an incline of fifty degrees, and a slope of fifty-five degrees is absolutely inaccessible.

† [A brief sketch of the labours of M. Elie de Beaumont is given in the Appendix, Note I.]

almost every point from the surrounding plain. Above these heights, which mark the actual limits of the volcano, an arched plateau rises on all sides towards the mountain by an insensible inclination of two or three degrees. This kind of pedestal supports an elliptical cone, which forms the lateral declivities of Etna, and which has a tolerably regular inclination of seven or eight degrees. These lateral slopes abut on the central elevation—the *Mongibello* of the Sicilians, whose highest part is terminated by a small inclined plane, called the *Piano del Lago*, which is itself surmounted by the terminal cone in which lies the great crater. From the *Piano del Lago*, there detach themselves, to the east, two narrow and almost abrupt craters, which form a part of the central elevation, and enclose with two arms, as it were, a great valley known under the name of the *Val del Bove*. The internal walls of this valley are often perpendicular, while the external walls present an inclination of about thirty-two degrees.

Such are the different parts into which modern writers have divided this great mountainous mass; but there is another division, which has long been recognised, and which, as it adapts itself better to the recital of the journey, we shall consequently follow. According to this mode of description there are three *zones* or concentric *regions*, which it is very easy to distinguish. The first comprises the level ground; this is the fertile region—*regione colta*, *regione piemontese*, which is celebrated for the fertility of the soil, the clearness of the atmosphere, and the salubrity of the climate. From the earliest historic

ages to our own day, numerous and rich cultivators have occupied this district. And here on this narrow space there are grouped together sixty-five townships or villages, which contain a population of about 300,000.* The second zone is the woody region—*il bosco, regione silvosa*; it owes its name to the thick forests with which it was formerly covered, and which still, at different points, give shade and shelter to this part of Etna. This woody region comprises the lateral declivities and a great portion of the central elevation of the mountain. From this region to the summit, there lies a third zone, which is known under the name of the desert region—*regione deserta, regione netta,* and is in reality nothing more than a vast wilderness, where there is an incessant contest between the fire which smoulders beneath the rocks of the mountain, and the snow which during nearly the whole year covers the summit and declivities.†

More than 200 conical eminences, varying in height, but generally of a very regular form, and hollowed in their interior into a sort of funnel-like cavity, are scattered from the extreme limits of

* G. Gemellaro.

† This contrast strikes all those who visit Etna, and it has furnished poets with several antitheses, which on this occasion at all events express the truth.

"*Scit nivibus servare fidem, pariterque favillis.*"

CLAUDIAN.

Summo cana jugo cohibet, mirabile dictu,
Vicinam flammis glaciem, æternoque rigore
Ardentes horrent scopuli.

SILIUS ITALICUS.

the cultivated region as far as the Piano del Lago. These extraneous cones are like so many blow-holes, through which the subterranean fires have made their way at different epochs. The origin of the greater number is lost in the darkness of pre-historic ages, but all belong to the present geological epoch, and appear to be exclusively formed of ashes and scoriæ. Most of these are scattered over the woody region, raising far above the trees their summits, which are either green or bare according as their formation is of more or less ancient date. These secondary volcanos diminish in proportion as we ascend the mountain; and a very small number only are to be met with near the summit.

The mode of distribution of these extraneous cones is in complete accordance with the observations which have been made during the eruptions. It is of rare occurrence to find that the great crater is alone in a state of activity. In rising towards the mouth of this gigantic furnace, the lava acts upon the sides of the mountain precisely in the same manner as a hydraulic press, and in general the earth is broken and opened by the action of this enormous force. The burning torrent escapes through this opening at the same time that it carries away with it gaseous emanations, and throws into the air the *débris* of the soil, which, falling back around the recent volcano, soon invests it with a new cone, the eternal monument of its transitory existence. Of the eighty eruptions whose date is more or less well attested, only twenty-two are looked upon as belonging to the great crater.

And, indeed, in the majority of cases, the mountain has at these times ejected only cinders and stones.

After having explored Catania and its immediate vicinity, and after having collected numerous facts to which we shall have further occasion to revert, we resolved on an expedition to the volcano itself. The Signor Abate, our host, who is a treasure to those travellers who are anxious to make the ascent, undertook to provide all things necessary for our excursion. Accordingly the three mules which were destined to carry us, were laden with a large assortment of travelling cloaks and ample provisions — precautions which, although they seemed to us extremely unnecessary before we began our excursion, were found to be far from useless. It may be said that the ascent of Vesuvius is a mere walk, that of Stromboli a fatiguing excursion, and that of Etna a short, but an invariably arduous journey, which is not unfrequently beset with dangers. On these elevated slopes, where the ice is scarcely ever entirely melted, violent tempests and sudden gusts of hail and snow frequently beset the traveller who has begun the ascent under a serene and cloudless sky. Moreover, in quitting Catania to reach the summit of Mount Etna, the variations in the temperature and in the atmospheric pressure are very considerable. The thermometer, which during the day and in the plain has stood at 104° F. in the shade, or at about 140° F. in the sun, often falls below the freezing point during the night which the traveller is obliged to spend at the foot of the cone.

In consequence of the weight of the atmosphere, a man of medium height supports at the level of the sea a pressure of about 22,775 lbs., but when he reaches the margin of the crater this pressure will not exceed 15,258 lbs.; thus during this double journey, which generally occupies a space of forty-eight hours, the traveller is twice obliged to support a variation of temperature of at least 72°, and a variation of pressure of 7517 lbs.

We left Catania at break of day, and crossed the cultivated zone by a carriage road. These first gentle acclivities of Mount Etna present an appearance which is at once cheering and depressing. At every step we advance, we tread upon a soil covered by rich crops of corn and olive groves. We pass through villages, in which everything announces ease and competency, and we find on the road side charming cottages, or small and comfortable farmsteads, whose white-washed walls are half hidden beneath the luxuriant tendrils of the vine or the foliage of richly laden fruit trees. But the earth we tread upon is a bed of volcanic cinders; the waving crops, the richly laden cherry orchards, the pomegranate trees, the flowering orange, have all sprung up on lava, which has scarcely been pulverised by the slow action of time. The lovely villages through which we passed, the charming country houses which we stopped to admire, are built of lava and cemented with *pozzolane*. Not unfrequently, indeed, the very verge of an ancient crater has served for the site of some smiling cottage, whose beauty had attracted our attention. At every step

we take, we are traversing or skirting along some more recent lava bed whose arid and upheaved *cheire* * covers fields which were once as fertile as those which it now intersects in the form of a huge black dyke. Everywhere, by the side of present happiness and wealth, we see the phantom of past desolation and misery, making us tremble for the future.

We more especially experience this feeling when after having passed beyond the little hamlet of Mass-annonziata, we see rising behind the houses of Nicolosi, the double summit of Monti-Rossi. This is the crater which in 1669 buried under a shower of ashes all the neighbouring country, and even threatened Catania with complete destruction, although it was situated at more than twelve miles' distance from it. Excavated by the violence of the eruption which produced it, it has preserved the form of two cones in juxta-position to one another, and both rising to a height of nearly a thousand feet, the dark red colour of their scoriæ contrasting in the most striking manner with the surrounding objects. A stream of gigantic scoriæ issues from the base of this mountain; and bending in a southerly direction, falls into the sea to the southwest of Catania, being more than three miles wide in several parts of its course. The whole of this tract is covered with an arid and bare *cheire*, and among the enormous

* *Cheire* or *schiarra*, in the Sicilian patois, is the name given to the surface of a lava bed, which has cooled on slightly inclined slopes in such a manner as to become charged with more or less considerable blocks of the same substance.

blocks which have been cooled for more than two hundred years there is scarcely one which exhibits any traces of the action of time. All are of a deep black colour, and their edges and angles are as sharply cut as if they had been cooled and broken up only the day before. Not a blade of grass grows on these rocks, which seem to repulse every form of vegetation, excepting here and there, where a few lichens, in thin and irregular patches, appear to struggle for their very existence.*

On our arrival at Nicolosi, we were received by Doctor Mario Gemellaro, one of those three brothers who, not satisfied with having consecrated their lives to the observation of the phenomena of Etna, have endeavoured by every means in their power to facilitate to travellers the study of their cherished mountain.† Before their time, the tourist who visited Etna was obliged to sleep under an ancient lava bank, where a poor shelter was furnished by a recess in the rock, known as the *Grotta delle Capre;* and in order to reach the summit of the cone before

* In his letters on Sicily, Von Borch pretends that the lava of 1669 has been covered with one inch of soil. This is an error of observation which it is very difficult to explain, and which has already been noticed by Spallanzani. See his *Viaggi alle due Sicilie.* Even in our day the *cheire* of 1669 possesses no other soil but that which has been transported to it.

† The family of Gemellaro numbers amongst its members three brothers, who have all attained to distinction; one of them, Giuseppi Gemellaro, the author of a plan of Etna, died several years ago. A second brother, Carlo Gemellaro, is still a professor at the University of Catania. Mario Gemellaro, a physician at Nicolosi and a learned naturalist, has published several highly interesting memoirs on the meteorology, botany, and geology of Etna.

sunrise, it was necessary to climb during the greater part of the night the steepest and most dangerous declivities of the mountain. In 1804, the brothers Gemellaro caused a small cottage to be erected at their own expense on the borders of the Piano del Lago, and having furnished it, the key was given in charge to Dr. Gemellaro. This first cottage, or *casina*, was destroyed in 1806, but its place was soon supplied by a second, which was known as the *Casina Gratissima*. Five years afterwards, in 1811, a portion of this building was thrown down by an earthquake, and the furniture destroyed. Without suffering themselves to be discouraged by this disaster, the three brothers resolved to erect a larger building in which travellers might find shelter for their mules as well as for themselves. They chose as the site of the new *casina* a small hill, covered with *lapilli* *, not far from *La Gratissima*, and sheltered on the side of the volcano by the perpendicular walls of the lava beds of 1754. With the exception of the stone, all the materials had to be carried on the backs of mules for a considerable distance, and as the expense of the undertaking would have far exceeded the limited means of the three brothers, they requested some assistance from Lord Forbes, who was in command of the English troops which at that time occupied Sicily. A subscription was opened,

* The term *lapilli* is applied to fragments of light scoriæ, whose average size is about that of a walnut. The same substance, when reduced to the volume of grains of sand, or when finely pulverised, constitutes, properly speaking, the volcanic cinders or ashes, which in no way resemble those of our fires, or even those to be met with in forges.

and under the direction of Doctor Mario Gemellaro a substantial house was soon erected, which has hitherto been spared by the volcano.

Nevertheless the perseverance of the brothers Gemellaro was doomed to suffer many other trials. As soon as the house was completed, they supplied it with furniture and an adequate provision of firewood. Attracted by these treasures, the herdsmen of Mount Etna broke open the door, and carried away all the furniture, and this damage which was soon repaired, was more than once repeated. At length, in 1820, at the period of the Austrian occupation, some of the officers who were garrisoned at Catania, resolved to visit the volcano. As natives of the north, they thought they might dispense with every precaution, and therefore did not condescend to ask for the keys of the *Casa Gemellaro.* On reaching the summit of the mountain, however, they began to suffer from the intensity of the cold, and breaking open the doors of the house, burnt the furniture as firewood. After this, the brothers yielded to their destiny, and remaining satisfied with having secured a shelter for travellers, they provided the *casa* with furniture not likely to tempt the cupidity of the mountaineers, and whose low price would enable them to replace it in case of future accidents.

We have designated this house under the name of the *Casa Gemellaro,* which we think it only an act of simple justice to bestow upon it. It is very generally known, however, under the name of the English house, *La Casa Inglese.* The following

words are inscribed above the entrance: *Ætnam perlustrantibus has ædes Britanni in Sicilia, anno salutis* 1811. Not a word is here said of those who took the initiative, who erected the first *casine*, and who at the present day consecrate their fortune to the maintenance of the *casa*. It would seem as if Lord Forbes and his officers considered that the merit of having supplied the funds necessary for the *completion* of the edifice, gave them the right of monopolising to themselves the entire credit of the construction, and the undivided gratitude of travellers.

After having received all necessary instructions from Doctor Gemellaro, and having come to an understanding with the guide whom he had engaged for us, we resumed our course. Nicolosi marks the limit of the cultivated region on this side of Etna. The last houses of the village abut upon a hill of black and moving sand, where here and there a large broom, with its pendent branches of golden coloured corollas, rises from the dark soil around it.* Having passed these, we traversed a large plateau of entirely

* Notwithstanding their large size, these brooms belong to our common species (*Genista scoparia*), which in these southern regions attains a height of from twenty to twenty-four feet. This shrub, which has been too much neglected by our horticulturists, might be made very valuable in a commercial point of view from the facility with which it thrives even on land which is very ill adapted for the growth of trees. Its slender and flexible branches furnish textile fibres, which, although they are no doubt inferior to those of flax or hemp, or even to those of the Spanish broom (*G. junca*), might, if carefully prepared, furnish a very valuable substance for the manufacture of coarse canvas and linens, and would be found important from its abundance and cheapness.

exposed lava, and here began our fatigues. The *sirocco* was blowing, and even at Doctor Gemellaro's house the thermometer had stood at 104° F. in the shade. Scorched at once by the direct rays of the sun and by the reflection of these masses of stone, we endeavoured to hasten the tardy pace of our mules, that we might the sooner reach the *woody region*, whose sombre verdure seemed to promise from a distance both shade and coolness. Our disappointment was, however, great, when on reaching this much desired goal we found only a carpet of ferns, interspersed here and there with a few ancient trunks of branchless oaks.

The southern side of Etna presents everywhere the same spectacle. In this vast space, which was formerly covered with primeval forests, there remains at the present day scarcely a single tree that has not suffered from the axe or fire. A lawsuit, which has been pending for fifteen years between the Prince of Palermo and the other proprietors, has occasioned all this devastation, for since the beginning of this unfortunate process no watch has been kept over the forest. The mountaineers, profiting by the opportunity thus thrown in their way, have hacked the trees, or set fire to their roots, in order that they might fall into their hands as dead wood, and owing to this avaricious improvidence, the forest has very nearly disappeared.

We continued to ascend beneath the rays of a burning sun. The path, becoming more and more steep, passed along a loose soil which was almost entirely formed of decomposed lava, and either from

time to time traversed some uncovered lava stream, or wound round the base of some ancient crater, which is now covered by vegetation, and stands forth like a pyramid of verdure. The fruitfulness of the woody region is remarkable, for here the flora of Etna which is so rich in species, seems at every step to dispute possession of the ground with the volcano, which is incessantly threatening it. This struggle gives rise to the most striking contrasts, for absolute sterility is often in immediate juxtaposition with the richest vegetation, as was forcibly exemplified in this portion of our excursion. For here all the slopes situated to the left of our road were concealed beneath a thick covering of green, surmounted here and there by trees, which looked as if they were merely balanced on their denuded roots. A few shepherds, followed by numerous herds, and who watched us pass with an air of indifferent curiosity, imparted animation to the scene. The shallow ground lying to our right presented an equally smiling aspect, but above us lay, like petrified torrents and cascades, the enormous lava beds of the *Boccarelle del Fuoco*, those twin craters, which in 1766 destroyed, according to the statement of Doctor Gemellaro, more than a million of oaks in this part of the forest.

After two hours' march we reached the border of the wood and the *Casa del Bosco*, a small hut which is built opposite to the *Grotta delle Capre*. It was past mid-day, but yet the heat was less intolerable. We had already reached a height of 6,233 feet above the point from which we started, and there remained

only about 3,000 feet more to climb in order to reach the Casa Gemellaro. This, however, was the roughest part of the excursion, and in order in some degree to renovate our strength, we resolved upon a halt. Our basket of provisions was now opened, and travellers and muleteers sat down together on the fine and close grass which is peculiar to high mountains, and here after partaking of a meal, which was seasoned by fatigue, we all fell asleep at the foot of an oak, covered with a few remains of foliage.

After a short siesta, we resumed the ascent, and entered the *desert region*. Here the vegetation decreases so suddenly that it seems almost wholly to disappear. The 477 species of plants, which grow in the woody region, are here reduced to about eighty, among which we must include more than thirty species of lichens *, but not a tree or a shrub is to be seen in these solitudes. The flora of Etna is here only represented by a few of the lowest forms of plants, which are scattered in tufts in the crevices of the rocks, or upon some of the slopes formed by the ancient lapilli. Thus it is impossible to conceive anything more desolate than this part of the mountain. Our eyes were wearied with gazing on these slopes, which were uniformly covered

* These numbers have been taken from a work, entitled, *Chloris Ætnensis, o le quatro florule dell' Ætna*, by Signor C. S. Rafinesque-Schmaltz. The author of this treatise, after having resided for a long time in Sicily, settled in America, and has published amongst other works the *Ichthyology of the Ohio*, which is often referred to by Cuvier.

with old lava, or with gray ashes. The path now became scarcely perceptible, and the mules, notwithstanding their habitual sure-footedness, stumbled at every step on this soil, which was at once moveable and hard. Nevertheless, we continued to ascend, and the temperature sensibly diminished. At the foot of Montagnuola, one of the most considerable of the secondary cones of Etna, the guides showed us the glaciers of Catania, which consist of vast masses of snow regularly arranged below a thin stratum of sand. A little higher up the snow was completely uncovered *, and here we were obliged to have recourse to our cloaks and wrappers, but very soon even this extra clothing proved insufficient to protect us from the cold, and in order to retain some slight degree of warmth, we were obliged to leave

* The German geologist Hoffmann, who visited Etna in 1830, made some interesting observations on the desert region, which we give in the subjoined table.[1]

	Feet.
Limit of the woody region on the road from Nicolosi to the crater	5470
Extreme limit of vegetation	8628
Limit of the vegetation of the Astragalidæ	7429
Limit of the vegetation of the Berberidæ	7110
Limit of the vegetation of the Pteris aquilina (common bracken or fern)	5619
Limit of the snow under the Montagnuola, Oct. 19th	7909

Archiv für Mineralogie, Geognosie, &c., 1839.

It ought to be observed that several of the plants mentioned by Hoffmann, rise on Etna to a much greater height than on any other mountain situated in the same latitude, which is probably owing to the internal heat of the soil.

[1] [The numbers in the above table have not been reduced to English feet, as it is uncertain whether they represent French or German measurements.]

our mules, and to climb on foot up the last portion of the ascent which separated us from the casa.

At the moment of our arrival, the sun which was nearly hid behind the western extremity of the island, cast the shadow of Etna over the Ionian sea, and gilded with its last rays the plains of Catania and Aderno. We paused for a moment to observe this magnificent panorama, which was abruptly interrupted towards the north by the cone of the great crater, which rose in the centre of the Piano del Lago to more than a thousand feet above our heads, but the cold did not allow us to remain till the night closed in. The thermometer had fallen below the freezing point, and, as we entered the casa, we showered blessings on the heads of those three brothers who, on a plateau rising about 9600 feet above the level of the sea, have provided travellers with a shelter against the keen north east wind, that had been freezing us to the very heart. Less fortunate than ourselves, our muleteers were obliged to descend to the foot of the Montagnuola in order to find a grotto to shelter their mules, as the stable of the casa was still blocked up by ice and snow. Our guide alone remained in attendance on us, and in a few seconds a narrow plate of lava had been converted into a *brasero*, on which a charcoal fire was soon blazing, around which we crowded with feelings of intense satisfaction. Our lamps were lighted, and our provisions spread on the coarse, but clean table, and while we were engaged in partaking of our frugal meal, our guide was preparing our bed by spreading a thin paillasse on the somewhat rickety planks

which served for a bedstead. After having filled the *brasero*, and taken every possible precaution for keeping up a good fire, we betook ourselves to our bed, which was certainly very far preferable to the lava floor of the *Grotta delle Capre*. Covered with our cloaks and wrappers, and huddled close to one another we soon fell asleep, notwithstanding the cold air which passed from the frozen ground through the badly formed frame of our bed.

At two hours after midnight the guide awoke us, and each of us grasping a stout staff, we set out by the light of the moon on our road to the crater. We experienced some difficulty in crossing the stream of lava, which in 1838 separated into two branches at the foot of the eminence on which the casa is built. We next passed over a bank of snow which craunched under our feet, and finally descended a gentle slope, covered with scoriæ. Here we found ourselves at the base of the cone, and we now began an ascent which was fully as arduous as that of Stromboli. The stones and sand crumbled away at every moment from under our feet, until by the direction of our guide we struck upon a lava bed lying somewhat further west, and here the ascent became less fatiguing. At last we reached the crater, where we stood motionless, wrapt in the contemplation of the spectacle presented to us.

At our feet yawned the great crater. It was not here a simple inverted cone or funnel as we had observed in all the secondary cones, and which is the case even on the summit of Vesuvius itself, nor did we see before us that uniform blackness of the rocks

and ashes which characterises Stromboli. The effects of the eruption of the preceding year were still apparent, and the crater of Etna at the period of our visit had the appearance of a deep and irregular valley beset with points and capes, and formed by abrupt slopes, bristling with enormous scoriæ and blocks of lava heaped up in masses, or rolled and twisted in a thousand different ways by the force of the volcanic action, or the accidental influences to which they had been subjected in the act of falling. The blue, green, and white lava, stained here and there with broad black patches or streaks of dull red made the livid colour of the surrounding rocks still more striking. A death-like silence reigned over this chaos; long lines of white vapour were noiselessly escaping from a thousand different fumarolles, and, trailing slowly along the sides of the crater, carried to the spot where we were standing suffocating emanations of sulphurous and hydrochloric acids. The pale light of the moon joined to the rising dawn was a fit accompaniment to this wild scene, whose grand and truly supernatural character no language can adequately express.

The soil on which we were treading was entirely composed of cinders and scoriæ, and was humid and warm, and covered with a white coating that looked like hoar frost. This humidity was, however, in fact the acid emitted from the crater, which moistened and corroded everything that came in contact with it, while the silvery film on which a few crystals were sparkling was a deposit of sulphur sublimated by the volcano, and of salts formed by the chemical re-

actions which were incessantly occurring in this formidable laboratory.* By following the narrow ridge, which borders the crater to the south, we reached the highest point which is situated on its eastern extremity. Here an indescribable spectacle presented itself to our gaze. The sky was perfectly pure, the air was exquisitely transparent, while the horizon, which from the shortness of the twilight was now brightly illumined, appeared to have no other limits than that which resulted from the curvature of the earth's surface. From our lofty pedestal, we looked down a depth of four or five thousand feet upon the highest summits of the Peloriân and Madonian mountains, while the whole of Sicily lay spread before us as on a map.

To the west the eye wandered along the summits of Mount Corleone, half hidden by the vapour which concealed Mount Eryx from our view. Beyond this limit, the sea spread far and wide on every side, serving as the frame to this glorious picture of nature. And here we could trace the route we had followed for more than four months in circumnavigating the island in the *Santa Rosalia.* To the north we saw the mountains of Palermo, and still more clearly Milazzo, the islands of Vulcan, and the black and regular pyramid of Stromboli; while we could even distinguish every undulation of the soil, and trace every indentation of the coast-line along the straits of Messina on the rocky shores of Calabria. Nearer still, the massive form of Etna presented its three con-

* These salts are, according to M. Elie de Beaumont, principally sulphates.

centric zones, all perfectly well defined, with its sixty-five villages lying in the midst of rich campagnas, furrowed and broken up by the lava beds, which diverge from the centre like so many black radiating lines. To the south the eye embraced in one glance Augusta, Syracuse, and Cape Passaro, around which the coast seemed to bend back upon itself, as it were, disappearing finally amid the mist which enveloped the coast at Girgenti. Wrapt in mute admiration we cast our eyes from one extremity to the other of this immense circle, when suddenly the guide exclaimed, "Eccolo! ecco il sole," and truly there was the sun, which, raising its ensanguined orb before us, bathed, in one universal tinge of purple, earth, sea, and sky, and projected to the very limits of the horizon, and across the entire island, the gigantic shadow of Etna, which, becoming more and more contracted, grew also more distinct in proportion as the sun rose higher above the Ionian Sea.

Light vapours were now everywhere curling upwards from the earth, as it began to be warmed by the rising sun. First thin and airy, they gradually thickened, and soon contracted the horizon on every side. After throwing one last look at the valley of the crater, we left our place of observation and descended towards the foot of a Mamelon which lay to the east. Our guide soon stopped us near a narrow and steep declivity, which was entirely detached from the rounded margin of the cone, and abutted upon a precipice which descended to a depth of several hundred feet. Here we saw him roll up the sleeve of his jacket and apply it to his

mouth, a proceeding which he signified by signs that we must imitate, rushing forward across the slope as he exclaimed, "Fate presto." Without hesitation we followed him, and speedily reached the margin of the mouth which in 1842 had thrown its lava into the Val del Bove, and which, being reopened by the eruption of 1843, appeared still to threaten the neighbouring district. It was from hence that the smoke issued which we had seen from Giardini, and it was from the depths of its abysses that we had from time to time heard rolling peals of subterranean thunder.

Here all description becomes absolutely impossible. A vast irregularly circular enclosure formed by perpendicular walls encircled the chasm. To the left, at the foot of the escarpment, a large blow-hole had opened from which darted forth eddies of fiery red smoke. In the centre, to the right, everywhere lay enormous blocks of lava, that had been shivered, cracked, and torn, some black, others of a dark red, but all exhibiting in their crevices, the vivid tints of the lava from which they had been formed. A thousand streams of white or gray smoke were crossing and recrossing each other in all directions, with a deafening noise and with a whistling sound, similar to that of a locomotive from which the steam is escaping. Unfortunately we could do no more than throw a hasty glance at this strange and terrific scene. The hydrochloric acid entered our throats and penetrated to the last ramifications of the bronchial tubes; and with haste, and almost intoxicated, as it were, we regained the protecting

slope, where we might breathe more at our ease, and then resting on our staffs, sprang to the edge of the declivity which was solely composed of moveable *débris*, and in five minutes we had reached the base of the cone, which it had cost us more than an hour to ascend.

Our mules were waiting for us at the casa, and no sooner had they received their light load of wrappers, and cloaks, baskets and panniers, than they descended by the straight and nearest track, while we diverged to the left in order to obtain a view of the Val del Bove. This excursion was perhaps the most arduous part of our whole journey. The wind was blowing from the north-east, and in a few minutes it had grown into a perfect hurricane. Its icy breath raised clouds of sand and gravel which pricked and stung our faces and hands as if with so many needles. We found considerable difficulty in reaching the *Torre del Filosopho*, a small and ancient monument which is now in ruins, but which according to Sicilian legends was the habitation of Empedocles. The probability is, however, that this was once a tomb, most likely dating from a period not earlier than the time of the Roman Emperors. The Torre del Filosopho nearly touches the escarpment of Serre del Solfizio, which bounds the Val del Bove on the side nearest the volcano. Standing upon these perpendicular rocks, we admired this immense circuit, which measures more than six miles in length and more than three miles in breadth, and whose walls, which are almost everywhere perpendicular, and formed of masses of lava

older than the human race, often rise to a height of more than one thousand feet from the base, which is almost entirely composed of recent *cheire* superposed upon one another. The hurricane, however, whose violence was now redoubled, soon obliged us to leave our post, and hastening onwards, we passed almost without a moment's pause before the Cisterna, an enormous chasm in shape like an inverted cone, which has opened in the midst of the Piano del Lago. We at length found shelter behind the Montagnuola where our mules were waiting for us. Three hours afterwards we reached Nicolosi, and after offering our thanks to Doctor Gemellaro, we subscribed our names on his register below the signatures of Leopold von Buch*, Elie de Beaumont, Constant Prevost, and Adrien de Jussieu. That evening we rested at the house of Abate, and seated round his table, which is the best provided in Sicily, we forgot our fatigues, and thought only of the grand spectacle by which they had been rewarded. After having visited Etna, we are better able to appreciate the enormous power of the forces which are brought into play in this part of the globe, and we no longer regard as exaggerated the recital of those eruptions

* Leopold von Buch, a foreign associate of the Institute, who died in 1853, was one of the founders of modern geology. The theory of upheavals owes to him some of the most conclusive proofs on which it is based, and he was the first who referred chains of mountains, which were parallel to one another, to contemporaneous upheavals. It is well known how much M. Elie de Beaumont has extended and enlarged these first data. Among the works which Leopold von Buch has left, we may instance as a model for other writers, *Physikalische Beschreibung der Canarischen Inseln.*

which from time to time have shaken the whole island of Sicily, and whose effects have been felt even at Malta and in Calabria. We will endeavour to give some idea of these terrible devastations, by relating the history of the eruption of 1669 as it has been described by Recupero.* Independently of the interest which attaches itself to this disastrous event, we are led to give this narrative with a view of drawing attention to certain facts that have been attested by a great number of eye witnesses, and which have not perhaps been sufficiently regarded. In perusing these simple narratives which have been so naïvely written by ignorant monks or village curates, and which have been collected by Recupero, one is surprised to find that they afford a refutation, quite involuntarily indeed, of many errors which have found credence amongst some of our

* *Storia naturale e generale dell' Etna, del Canonico Giuseppe Recupero, arrischita di moltissime interressanti annotazioni dal suo nepote, tesoriere Agatino Recupero.* Catane, 1815. This work, which is too little known out of Italy, contains a large number of original documents, which have been principally extracted from the archives of several towns and convents. The information relating to the eruption of 1669 has been extracted more particularly from a manuscript preserved at Nicolosi, which was written by a certain Don Vincenzo Macri, Chaplain to the Church of Nicolosi. The author reports at great length, and with an irresistible air of truthfulness, the events which he saw, and to which he nearly fell a victim. Recupero consulted amongst others, the writings of eleven learned Sicilians, a narrative left by the Earl of Winchelsea, English ambassador at Constantinople, and another memoir by the celebrated Borelli. He has joined his own observation to the testimony of these writers, all of whom were eye witnesses of the events that they record. The facts stated in his work appear to us, therefore, to present every possible guarantee for their accuracy.

most eminent *savants*, and which have even been admitted into technical works which are on other accounts most justly esteemed.

On the eighth of March, 1669, a terrible hurricane arose suddenly at break of day and continued to rage for about half an hour, shaking all the houses of Nicolosi, and thus serving as a precursor to the disasters which were about to lay waste the country. The following night was ushered in by an earthquake, and the shocks gradually increased in intensity until the Sunday, when the walls of the houses began to fall in. The terrified population sought safety in the open country, and during the night of Monday a formidable shock threw down all the houses of the town. The earthquake now became more violent from hour to hour. The trees and the few huts that were still standing, oscillated like so many pieces of wood floating on the surface of a troubled sea, and men, unable to keep their footing on this moving ground, stumbled and fell at every fresh undulation. At this moment the earth opened for a length of twelve miles from the Piano di San Lio to Monte Frumento, one of the secondary cones which lie the nearest to the summit of Etna. The fissure thus made inclined from south-west to north-east, and was from four to six feet wide, but its depth could not be sounded, notwithstanding the frequent attempts that were made to ascertain it. At length the flames of Etna burst through the soil, which had been so often broken and rebroken. The first mouth was opened to the west of Monte Nucilla, and threw into the air a column of sand and

smoke, which was estimated by the inhabitants of Catania to have risen to an elevation of more than 1200 feet. In the space of two hours, six other mouths were opened, all of which were placed in a longitudinal line, and in the same direction as the fissure of which we have spoken. A black and thick smoke issued with a horrible noise from these blow-holes, new craters were formed in the course of the day, and on the Tuesday morning the crater appeared from which arose the Monti Rossi.

This last opening at first ejected a thick smoke mixed with burning scoriæ, but after the course of a few hours its mouth gave vent to an immense quantity of lava, which forming a stream nearly three miles wide and ten feet high, took a southerly direction and struck against the base of Monpilieri, an ancient crater which was then covered with trees and other vegetation. The burning stream penetrated through this somewhat shallow soil, and forcing itself a passage across the mountain, it flowed for some time along this self-made aqueduct, but Monpilieri having partially broken down, the lava flowed round it, encircling it like an island of verdure lost in the midst of flames. Seven secondary mouths opened at the same time round the principal crater. They were at first isolated, and threw up into the air an enormous quantity of burning stones, which struck each other as they fell back and joined the noise of their fall to the terrific artillery of the volcano. At the end of three days they were united into one vast and horrible chasm of fully 2500 feet in

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circumference, which from the 11th of March to the 15th of July never ceased to pour forth its thundering roar, to eject cinders and scoriæ, and to vomit forth streams of lava.

Up to this moment, the great crater had remained as completely inactive as if its caverns had no communication with those of the new volcano; when all at once, on the 15th of March, towards ten o'clock at night, the entire mountain seemed to shake. First a gigantic column of black smoke and fire darted upwards, and then with a horrible noise the summit fell piece by piece into the abysses of the volcano. On the following day four daring mountaineers ventured to make the ascent. They found the surface of the soil depressed round the crater, and all the openings which before had surrounded it engulfed and swallowed up, while the orifice whose circumference had formerly not exceeded three miles, now measured double that length.*

The torrent of lava which had issued from the Monti Rossi still continued its course in a southerly direction. Its different branches reached a length of nearly four miles. Each day new streams of liquid fire flowed over the substances that had been partially solidified since the previous night, thus widening the beds of the different streams which encroached upon the various islands of land that had been temporarily spared. Already the villages of Belpasso, San Pietro, Camporotundo and Misterbianco had been almost entirely destroyed, while their rich

* The measurements given by Recupero are probably somewhat exaggerated.

territories had wholly disappeared beneath these incandescent masses. On the 4th of April the lava came within sight of the walls of Catania, and extended on to the Campagna of the Albanelli. Here, as if to show its power, it first lifted up and transported to a considerable distance an argillaceous hill, covered with cornfields, and then an entire vineyard, which floated for some time on its burning waves. After having levelled various inequalities of land, and destroyed several other vineyards, the lava at length reached a broad and deep valley, called the *Gurna di Niceto.* The Catanians now believed themselves secure from further danger, for they thought that the volcano would exhaust its forces before it could fill this enormous valley. What must then have been their terror, when they discovered that in the short space of six hours the valley was completely filled, while the lava, flowing straight towards them, stopped at a stone's throw from the walls, like an enemy who pitches his camp before the fortress which he is about to assail.

The 12th of April seemed destined to witness the ruin of Catania, for a stream of lava nearly a mile and a half wide, and more than thirty feet high, advanced in a direct line towards the town. Being fortunately struck in its course by another current which was flowing westward, it turned aside, and running within a pistol shot of the ramparts it passed beyond the harbour, and finally reached the sea on the 23rd of April. Then began a contest between the water and the fire, which even those who were eye witnesses of these terrible scenes seem to have

felt the impossibility of describing. The lava, which was cooled at its base by contact with the water, presented a perpendicular wall of about 1500 yards in extent, and thirty or forty feet in height. As it slowly advanced, it carried with it, like so many blocks of ice, enormous solidified masses, which were still red-hot. On reaching the extremity of this moving causeway these blocks fell into the sea, and gradually drove back the waves in proportion as the fluid mass advanced. At the point of contact between the two elements, enormous masses of water were converted into vapour, which rising with a horrible whistling sound, hid the sun behind a thick mass of clouds, and then fell in salt rain over the neighbouring country. In the course of a few days the lava had caused the coast line to advance some 900 feet further into the sea.

New affluents continued to increase the burning stream, whose current after being incessantly widened, at last reached the ramparts of Catania. Day by day the stream rose higher and higher, until it was even with the top of the walls, which no longer able to support this enormous pressure, gave way on the 30th of April for a space of about 120 feet, and the lava at once entered by the breach which had been thus made.

The part of the town that had been broken in was the highest, and Catania now seemed doomed to total destruction, when it was saved by the energy of three men who ventured to contend with the force of the volcano. Doctor Saverio Musmeci and the painter Giacinto Platania, conceived the idea of

constructing walls of dry stones, which being placed in an oblique position before the current, were intended to divert its direction. This method was partially successful, but the Dominican brother, Diego Pappalardo, devised another which promised even better success. The beds of lava become encased, as it were, in a sort of solid canal, formed of blocks of cooled lava cemented together. The liquid mass protected by this kind of casing, is able to extend its ravages to a greater distance by preserving its fluidity. Dom. Pappalardo conceived that by knocking down these natural dykes at some favourable point, he might open a new channel for these burning waves, and thus dry up the torrent at its very source. Followed by about a hundred active and vigorous men, he made an attack upon the stream not far from the crater with hammers, clubs, and sticks. The heat, however, was so intense, that every man was obliged to fall back to recover his breath after he had struck only two or three blows. However, by continued efforts, and by the aid of iron clamps, they contrived to demolish a portion of the dyke, and in accordance with Pappalardo's expectations, the lava diffused itself through this opening. But the new current turned in the direction of Paterno, and the inhabitants of this town in fear of seeing the scourge which had threatened Catania fall upon themselves, sallied forth armed, and attacking Pappalardo, obliged him and his brave companions to retreat.

This proceeding was, however, so far successful, that the lava was unable to overwhelm the whole

town, and on the 8th of May it stopped, after having destroyed 300 houses, several palaces and churches, and the garden of the Benedictines.* On the 13th of the same month a small stream flowed over the rampart to the south of the town near the Church della Palma, but a wall of dry stones which had been hastily constructed, sufficed to arrest its further progress. The Catanians were less fortunate some days afterwards, when a new current invaded the castle, filled up its fosses, and speedily reached the level of the ramparts. A dyke was immediately constructed to arrest it, but on the 11th of June the lava crossed the wall, and flowed through the town in the direction of the Convent of the Fathers of the *Monte Santo*. Here a new barrier was opposed to it, which succeeded in arresting it, and thus preserved one of the finest parts of Catania. From this period the lava ceased any longer to threaten the city, and flowed in a direct course into the sea.

The eruption, however, continued for some time longer, and Lord Winchelsea tells us that the cinders fell at Catania, and as far as thirty miles out at sea, with such violence and intensity as to be injurious and painful to the eyes. Nevertheless the violence of the volcano was now exhausted. After the 15th of July, it appears to have been limited merely to the ejection of cinders, scoriæ, and fragments of lava,

* The present garden of the Benedictines has been made up of earth brought at a great expense from a distance to cover this lava, which rises in the present day like an irregular rampart within a few feet of the walls of this monastery, which is undoubtedly the handsomest building in Catania.

which soon filled up the base of the crater and closed the mouths, which for four months and a half had hurled forth terror and devastation. Such was this mournfully celebrated eruption, which covered about fifty square miles with a stratum of thick lava which at certain points extended to a depth of 100 feet, and which after threatening utterly to annihilate Catania, had destroyed the habitations of 27,000 persons.*

Even at the present day, we can trace on the surface of the soil the remains of those terrible phenomena which occurred nearly 200 years ago. We have endeavoured in the preceding pages to describe the *cheire* which issues from the Monti Rossi, and if time had permitted, we might have found, as Recupero has done, the fifteen accessory mouths which mark, over a space of about 1500 yards, the direction of these subterranean forces. We might also have penetrated into the upper portion of that terrific fissure, from which was ejected the enormous quantity of sand which covered a space of nearly nine square miles to a depth of three or four feet, and thus spread sterility as far as the Calabrian district. Finally we might have descended into that *Grotta Dei Palombi*, which through the exertions of Doctor Mario Gemellaro, may in the present day be explored to a depth of more than 200 feet, where the traveller may contemplate one of the still yawning chasms which has been produced by the dislocation of the ancient strata.

* Narrative of the Earl of Winchelsea as given by Recupero.

Without, however, having left the district of Catania we had found ample opportunity of ascertaining the force of the volcano, and verifying the truth of the descriptions which we had read of its destructive action. To the north and to the west of the town we had beheld the lava beds, which threw down and crossed the ramparts, and to the south we had been able to trace the course of those undulating streams which overtopped the walls that had been constructed by Charles V. We had seen the formidable thickness of this destructive stratum on descending the stairs of the *Pozzo di Vela,* a sort of well hollowed out in the direction of the outer side of this wall, at the base of which Prince Biscari has found the bed of the river Amenano,* which dis-

* The river Amenanus of the ancients. This part of the town presents a very curious aspect. The lava, which reached to the level of the parapet, only flowed over it at a few points; a circumstance which shows us very plainly the mode in which the stream progressed. The lava did not *flow* along the wall like a fluid or viscous liquid, but formed a sort of irregular pyramid, whose base rested against the wall, and whose lateral slopes exhibited as great an inclination as a steep flight of stairs. The lava consequently comported itself very much in the same manner as any mass of solid matters when thrown down an incline.

These facts do not harmonise with the ideas which are commonly entertained in reference to the nature of lavas generally, more especially with respect to their cohesion. Lava streams very rarely preserve their fluidity for any length of time, for on being brought into contact with the air, their surfaces harden and offer very great resistance, even while they are flowing with considerable rapidity. M. Blanchard and myself were enabled to confirm these facts within the crater of Vesuvius. On throwing with all our force several porous stones upon a current of lava which had burst forth at a few paces from us, and whose surface appeared perfectly smooth, we

appeared at that fatal epoch. We had also traversed the *cheire*, which had advanced into the sea beyond the harbour in the form of a promontory, whose surface resembles that of a river on which the ice is breaking up, and whose immoveable and dark blocks frequently present surfaces of several hundred square feet, and are from fifteen to twenty feet in thickness. In visiting spots like these, the very aspect

saw the stones rebound, and occasionally break in pieces on the surface of this apparently liquid stream. These facts, however, are well known to all those who have been eye witnesses of these terrible phenomena.

This special characteristic of the lava explains to us how several venturesome travellers, and amongst others, Hamilton and the Marquis Galliani, were able to cross moving lava beds, without experiencing any inconvenience beyond the sensation of intense heat in the feet and legs. It ought further to be observed that stony substances are bad conductors of heat, which will explain on the one hand how it is that the lava proceeds with so much slowness; and on the other, why it requires so long a time before it becomes completely solidified and cooled. We have already shown that the burning stream which issued from the Monti Rossi continued its progress for forty-six days before it reached the borders of the sea, at a distance of about twelve miles, and nevertheless in this case the enormous mass of igneous matters that was constantly being ejected from the volcano accelerated its course. In the eruption which continued for ten years, viz. from 1614 to 1624, the current of lava although it was constantly augmented, traversed only a distance of ten miles. On the other hand, the lava of 1819 advanced at the rate of a yard a day nine months after the eruption had ceased. Spallanzani in 1787 saw a walking-stick smoke and catch fire a few minutes after it had been introduced into a fissure, which was still glowing from the presence of a stream of lava, that had been solidified eleven months before. The *cheire* of the eruption which we have described, continued to smoke, and to give off a very sensible amount of heat eight years after the lava had issued from the Monti Rossi.

of which produces a profound impression, in thinking of the terrible scenes of which it has been, and may again be the theatre, and in reflecting upon the terrific phenomena of which it is the permanent seat, the human mind is unable to limit itself to tranquil and calm observation. Hence endeavours have at all times been made to explain what is passing within this formidable mountain, and for many ages, from the want of better knowledge, recourse was had to supernatural explanations. Thus, according to the ancients, Encelades, struck by a thunderbolt, groans beneath the mountain which is crushing him; its devouring flames are the breath which issues from his chest, while the earthquakes which have shaken the whole of Sicily, are due to the convulsive struggles of the giant. To the Christians of the middle ages, Etna became one of the mouths of hell, and even at the present day, many a mountaineer hears the hopeless cries of the damned blending with the howls of demons within the innermost recesses of the mountain. Modern science has in its turn attempted to solve the problem, and supported by experimental inquiry and observation, it now seems very nearly to have attained to its final solution.

Considering the enormous quantities of lava, cinders, and scoriæ, which are ejected in every eruption of Mount Etna, men were originally led to regard its entire mass as derived solely from the successive accumulation of these materials. This theory which may be traced as far back as the Greek philosophers, long held undivided sway, and

even in the present day it numbers many distinguished geologists among its supporters.

A very partial view of the mountain is of itself sufficient to raise doubts in reference to the truth of this explanation. The slopes which have been formed by the accumulation of moving materials freely obeying the laws of gravity, all present in their contours straight and regular lines. The lateral slopes, the terminal cone of Etna, and the numerous secondary cones on the flanks of the mountain, possess in a high degree this character of regularity. In the most ancient of these cones, and in those which for ages past have been subjected to the action of atmospheric agents, more especially of heavy rains, the declivities may indeed have diminished, especially at the base, but they still remain regular in form, and their contours join the plain on which they stand by *continuous curves.*

The essential character of the profile of Etna, considered as a whole, is, on the contrary, *a want of continuity in its outline.* Between the parts which we have designated under the names of lateral declivities and central elevation, there exists a very perceptible break. The same is the case between the central elevation and the terminal cone. These facts appear in themselves to refer these different parts to different origins, and hence M. Elie de Beaumont has been justly led to observe, that a profound knowledge of the outline of Etna was almost a theory in itself.

The examination of the lava beds has led us to the same result, and here we will briefly mention

some of the laws which regulate their movements. It will be easily understood that a liquid or viscous mass will not comport itself in the same manner on planes of different inclination. When rapidly carried along a considerable inclination, such a fluid is unable to form a layer of the same thickness as it would attain on an almost horizontal surface. Wherever the inclination diminished the lava stream would be deep, and wherever the inclination was increased the stream would be shallow. Consequently, in order that a stream of lava should present an equal thickness over a considerable extent, it is necessary that it should flow along a uniform incline.

When we examine lava beds with whose origin we are acquainted, we always find that observation is fully in harmony with theory. On slopes of great inclination these lava streams only leave a narrow and thin bed which is almost entirely composed of scoriæ, that is to say, of portions already solidified by contact with the air, whilst they accumulate on reaching gently inclined slopes, and here form thick and compact strata. These very simple facts may be verified by the modern streams which intersect the mass of Etna in all directions, and we meet with very frequent examples of this on the road from Nicolosi to the crater, and a little above the Casa del Bosco.

Now when we penetrate into the Val del Bove, that strange and celebrated valley which bears inscribed upon it, in ineffaceable characters, the history of the formation of the volcano, we verify several facts

which appear to be in flagrant contradiction to the laws to which we have just referred. The interior escarpments of the valley are composed of several hundred strata, which are alternately formed by ledges of rocks and beds of fragmentary or pulverulent materials. These substances, which are very nearly similar at first sight to the lava of the present geological epoch, exhibit nevertheless a general tinge of grey, to which the deep black colour of the modern streams presents a strong contrast. They are moreover, like the latter, igneous rocks and true lava. All these strata are perfectly regular, and from one extremity of the valley to the other, that is to say, for about a length of six miles, their borders present the most perfect parallelism, without enlargement or constriction.

To explain this result, we must necessarily admit that, in issuing from the earth in a liquid state, these lava streams have flowed over a plane and nearly horizontal surface, where they could slowly cool and solidify. But yet, at the present day, their strata exhibit determined inclinations; and on the borders of the Piano del Lago they begin to dip, burying themselves under the tuffa of Etna, not far from the village of Milo. Moreover, in this long course they present various undulations and very great differences of inclination. At the Rocca del Solfizio they are almost horizontal; but below the Montagnuola, they assume an inclination of seventeen degrees. They again approach the horizontal line under the flanks of Mount Zoccolaro, which forms the southern enclosure of the valley; and then, after curving suddenly, they take a

strong inclination downwards, near the Porta di Callana, one of the eastern outlets of the Val del Bove. At some points this inclination amounts to as much as twenty-nine or thirty degrees.

If the lava of which they are formed had flowed over surfaces so much inclined as these, they must necessarily have presented considerable variations both in their mode of aggregation and in their thickness; but, as we have already observed, these strata are perfectly regular and parallel at all parts. All these strata rise and fall together, as the leaves of a book would do, if the whole were folded over one another in the same direction. We are, therefore, led to admit that at the epoch of their formation the soil presented a very different configuration from that which we now observe.

This conclusion derives confirmation from a still more striking fact. The walls of the Val del Bove are not formed exclusively of those long strata of which we have spoken, for an immense number of veins or lodes, of variable diameter, intersect them from below upwards at very different angles. These veins are composed of the same rock as the strata, and many of them, by intermingling with and following the direction of the latter, clearly show their real nature. It is evident that they are fissures through which the lava formerly escaped, and which have remained filled with the same substances which were ejected from them.

On examining one of these veins, abutting upon a lava bed on the middle of even a somewhat steep declivity, we find that the stream, without presenting

the slightest irregularity, is continued both above and below the point at which the liquid matter found vent; and, however numerous these veins may be, the strata are never thicker in the base of the valley than at the level of the Serre del Solfizio. It follows from hence that if, at the epoch of the formation of these strata, the soil had presented the same inclination which it now exhibits, the lava, instead of flowing in a mass towards the foot of the volcano, would in part have ascended towards the summit, contrary to the laws of gravity. All these facts admit, on the other hand, of a very natural explanation on the supposition which we have already advanced, that at the moment of the emission of this lava, the surface of the soil was horizontal, and that consequently these fused matters were able to distribute themselves freely in all directions.

We have hitherto only taken into account, in our consideration of the walls of the Val del Bove, those matters which formerly existed in a fluid condition. An examination of the strata which have been formed by ashes and scoriæ, would however, lead to the same result. If at the moment of their emission these fragments, which have been thrown into the air by a single mouth in the same manner as the modern lapilli, had fallen back upon inclined planes they would necessarily have comported themselves in the same manner as a mass of sand and loose stones falling down a flight of stairs. They would have smoothed the irregularities of the incline by accumulating upon the lesser slopes, and merely covering the steeper declivities by a very thin stratum. This

is precisely what occurs at each eruption on the great cone, the secondary cones, and the lateral slopes. These fragments preserve in the Val del Bove the characteristic parallelism of stratification of which we have already spoken. This fact would, therefore, be inexplicable, if we did not admit that they must have spread in a uniform manner over nearly horizontal surfaces.

Thus, on examining the profile of Etna, we observed that the regular declivities of the terminal cone and of the lateral slopes were suddenly interrupted by those of the central elevation, of which the Val del Bove is only a portion. Hence we concluded that this elevation could not be formed by the same process which gave origin to the cone and to the lateral slopes. The study of the lava beds leads us to the same conclusion; while, moreover, this observation teaches us that the strata of the Val del Bove must have been solidified on a horizontal surface.

To explain how a mountain of more than 10,000 feet in height has taken the place of a plain, and how it is that we meet at Piano del Lago with the same strata which dip below the campagna of Milo, we must admit that some force has upheaved this portion of the earth's crust. Such indeed is the conclusion at which M. de Beaumont has arrived. According to his opinion, the central elevation is the *primitive nucleus of Etna*, and this nucleus has been formed by upheaval.*

* It will be readily understood that in the brief exposition of the facts which justify this conclusion, we have merely adduced some of the most striking. We would, however, refer our readers for

We may now form to ourselves a tolerably exact idea of the successive phenomena to which Etna owes its present shape and proportions. The spot on which the central elevation now rises was originally a nearly horizontal plain, whose soil, broken up by the action of subterranean fires, has at different epochs given passage to currents of very fluid lava. This lava has spread into thin and uniform sheets around these blow-holes, and in solidifying, they have formed ledges of rocks, whose compactness depended upon the thickness of the streams. As in the case of eruptions at the present day, the ejection of these fused substances was accompanied by a violent liberation of elastic fluids, which carried with them large quantities of cinders, scoriæ and lapilli. These substances, which were extremely solid, issued from all the fissures, and falling back in a shower upon the bath of lava, have thus produced these uniform strata of stony and scoriaceous fragments which alternate with those composed of rocks.

These phenomena very probably continued to occur for many ages, but at length a moment arrived when the internal forces, which had so many times burst their way through the soil, displayed some extraordinary degree of energy, perhaps on account of the ever increasing resistance which was opposed to

further particulars to the original memoir of M. Élie de Beaumont. The maps and drawings which accompany the text will remove all doubts, and we more especially recommend to them the study of the plan, which was modelled by that geologist, and of which a copy is exhibited in the Jardin des Plantes.

their action by these strata, which had been continually augmenting in number and solidity. Unable to break through them, the internal forces upheaved them, and this violent movement necessarily broke them, by which a free communication was established between the bowels of the earth and the atmosphere. M. de Beaumont is of opinion that before this event there must have been at this point a multitude of *ephemeral volcanoes*, which, since that period, have been replaced by a *permanent volcano*.

But we know that in eruptions the ejected matter is not confined solely to solids and liquids, for the quantity of gaseous matter which escapes through the craters very far exceeds the volume of the lava and scoriæ. It is, therefore, easy to comprehend that the enormous vault formed by the upheaval of Etna must soon have needed support. Dislocated, moreover, by the very efforts which had given it birth, it must in a great measure have fallen back into the abysses which it had covered, and it is precisely to such a catastrophe as this, that the Val del Bove owes its origin. If this origin be once admitted, we shall be readily able to understand the striking relationship which exists between the craters that surround this valley, and the crater of the volcano itself. These craters are evidently continuations of one another, and collectively they form the circumference of the *ampulla* which had been upheaved on the surface of the soil. The vault, in falling in, exposed a section of the strata of which the escarpments of the valley were all equally composed, and which we again meet with on the Piano del Lago in the inte-

rior of that partial sinking, which we have referred to as *la Citerna.**

There was therefore an epoch in which the primitive nucleus of Etna rose solitary in the midst of the plain, towering above the whole island of Sicily with its abrupt and irregular outlines, but this condition of things was necessarily soon subjected to various modifications. Dating from the present geological epoch, the eruptions which have occurred upon its sides and round the central elevation have levelled the base of the mountain, and given rise to lateral slopes whose declivities and general aspect plainly reveal their origin. These lava beds, ashes, and scoriæ, were a sort of modern vesture, beneath which the volcano concealed its primitive form and veiled its origin. The winds, rain, and streams, have carried into the plain an enormous mass of these moveable substances, and thus gradually formed at different points slight elevations of the soil. We thus see that these secondary causes have incessantly tended to raise the base, and to level the plains; and it is to the same

* One is naturally led to ask at what epoch those phenomena can have occurred, of which we have endeavoured to give some idea in the preceding remarks. M. de Beaumont regards the upheaval of Etna, as having immediately preceded our present geological epoch. He believes that the outpouring of the ancient lava of the Val del Bove is contemporaneous with the formation of the chains of Atlas, the whole of which form a line bordered to the west by the Canaries and the Peak of Teneriffe, and to the east by Sicily and Etna. These determinations result from the general theory of upheavals and from the consequences which M. Élie de Beaumont has deduced from them as to the relative age of mountain chains. (See M. de Beaumont's work on Etna, and his article *Soulèvements* in the *Dictionnaire Universelle d' Histoire Naturelle.*)

cause that we must more especially attribute that general character of flatness which is exhibited by the entire mass of the mountain, notwithstanding its great height. It may be that, in the course of ages, the surrounding land may in this manner be so much raised, that the greater part of Etna may be buried beneath the products of its own craters.

It is not probable, however, that the primitive nucleus will ever wholly disappear. The quantity of matter ejected by the terminal crater is so small, that it scarcely suffices to cover the slightly inclined surface of the Piano del Lago; while on the steeper declivities this material is only accumulated in the crevices and ravines, in the same manner as we observe in the case of a slight layer of snow.

This fact, which at first sight is almost incredible, and which is so strongly opposed to many commonly received opinions, admits nevertheless of a very ready proof. The Torre del Filosopho is only separated from the terminal cone by a distance of about 100 yards. This monument is more than 2000 years old, and yet the volcanic products accumulated round its base had only acquired in 1807 a thickness of nine feet one inch.* The Piano del Lago, which is situated immediately at the foot of the great crater, does not therefore rise each year on an average more than one twenty-fifth of an inch from the accumulation of the direct products of the volcano, together with the materials which atmospheric agents may carry away

* These measurements were taken by Dr. Mario Gemellaro, and confirmed by Signor Agatino Recupero.

from the cone and distribute over this nearly horizontal surface. Here a curious comparison presents itself to our notice. The mud of the Nile every year raises the soil which it fertilises about one-twentieth of an inch; and thus, as M. de Beaumont remarks, he monuments of Thebes and of Memphis are being more rapidly buried under the alluvial deposits of this river, than the Torre del Filosopho is being entombed by the ashes of Etna.

Nevertheless, there is a fact which at first sight appears to be opposed to the preceding views. The terminal cone of Etna is formed with tolerable rapidity, for from time to time, as we have already seen, it sinks into the abysses of the volcano, and a few eruptions suffice to restore it to nearly its former dimensions. In 1702, the Piano del Lago presented the appearance of a plateau, in the centre of which there opened a gigantic funnel. This was the crater, which had been greatly enlarged, and whose orifice opened on a level with the ground, like that of a well which is unprotected by any parapet. The present cone is not more than a century old, yet in 1834 it was 1394 feet in height, while its circumference at the base measured 16,410 feet. Have the matters which have been ejected from the volcano been the only agents which have contributed to its elevation? If such were the case, it would be extremely difficult to explain why the Piano del Lago has not been completely overwhelmed by the cone during the course of nearly twenty centuries; and it would be more especially difficult to understand why such abundance of ejected matters should

only have covered the walls of the Torre del Filosopho to the depth of merely a few feet.

M. de Beaumont, indeed, admits that the phenomena of upheaval, which formerly gave origin to the mountain, are being reproduced in our own day, although with less intensity. He is of opinion that many of the cones, and more particularly the terminal cone, probably possess a solid nucleus, formed by upheaval, and that their external shape is due to a covering which is formed by the ejections of the crater, which thus disguise and modify the inequalities of the slopes. Finally, according to M. de Beaumont, Etna has not yet attained its greatest altitude, and according to his view, each new eruption tending to upheave it, may augment its height to an appreciable extent.

This mode of considering the eruptions does away with the apparent contradiction to which we drew attention, and facts are not wanting to justify this extension of his theory. In a great number of eruptions, the fluid lava has reached the very summit of the orifice, and has flowed over the margins of the great crater. The lava could not reach this elevation unless it were upheaved by an enormous power, whose action could not be limited to the vertical tube of the crater, but would necessarily be elsewhere exerted, and perhaps even over the entire mass of the mountain. Thus fissures have, several times been observed which formed a sort of radiation along the face of the volcano, the lines all converging towards the crater. After the eruption had passed, the margins of some of these fis-

sures were found to exhibit different levels; hence the soil must either have been raised on one side, or depressed on the other.

Many other phenomena might be adduced to prove that even in the highest parts of the volcano, the internal agents may produce phenomena of upheaval, but we will here limit ourselves to a positive example, which has been taken from the narrative of an eye-witness. During the eruption of 1688 there appeared in the highest part of the volcano, according to the statement of the Padre Massa, a large cupola of perfectly white snow, which rivalled in extent the domes of our largest churches, and in brilliancy the marbles of Paros and of Carara. Recupero justly adds, that this cupola must have resulted from some violent outburst of subterranean fire, which had raised and curved the superficial strata of soil that were at the time covered with snow.* We ought, moreover, to observe that these

* These dome-shaped upheavals, which are the direct result of an internal action, which, however, was not powerful enough to break the upheaved strata, were known to the ancients. Strabo and Pausanias have left us details regarding a phenomenon of this nature, which happened 282 years before our era, between Troezen and Epidaurus, and gave rise to the hill of Methone. Baron von Humboldt, from whom we borrow this fact, cites in his *Cosmos*, the verses in which Ovid recorded and explained this event, and he draws attention to the fact, that modern science fully justifies the description of the Latin poet. The following is the condensed abstract which Baron von Humboldt gives of this passage of Ovid:—"Near Troezen, is a tumulus, steep and devoid of trees, once a plain, now a mountain. The vapours, enclosed in dark caverns, in vain seek a passage by which they may escape; the heaving earth, inflated by the force of the compressed vapours, expands like a bladder filled with air, or like a goat's skin. The ground has

strata must have been of very considerable thickness, since they were able to protect the snow against the heat of the central fire which had caused their upheaval.

Without having seen the volcanic forces in all their intensity, we were able to observe, under circumstances which permitted us to distinguish their most minute particulars, the greater number of the phenomena with regard to which there has been so much discussion. On our return from Sicily, M. Blanchard and myself ascended Mount Vesuvius, and before we had advanced very far on this comparatively easy excursion, we were fully able to appreciate the truth of the remark made by Spallanzani, who observed that, "to those who had seen Etna, Vesuvius must appear like a mere cabinet volcano." As if in justification of the words of this celebrated naturalist, Vesuvius exhibited to us a miniature eruption, which struck us somewhat in the light of a laboratory experiment which we could observe at our leisure in all its various phases and details.

For the last two years the volcano seems to have been filling up its crater, which is now almost entirely full. Forty or fifty feet below the orifice, appeared a crust of black and spongy lava, somewhat like a pavement of irregular asphalt, interspersed with large blocks of lava, and enclosed by the inner sides of the crater, as by a circular wall. In the middle of this circus, which measured from 500 to 600 feet across, there rose a small cone from

remained thus inflated, and the high projecting eminence has been solidified by time into a naked rock." (*Cosmos*, Vol. I.)

thirty-five to forty feet high, from the mouth of which eddying clouds of fiery smoke, mixed with ashes and scoriæ, were being incessantly ejected, accompanied by a noise resembling that of musketry. Every day some opening was made in this lava floor, on the surface of which the liquid matter was freely poured forth, and then solidified. New strata were consequently formed on the top of the older ones, which, after being again partially fused, re-entered into the general mass. At the period of our visit, the crater of Vesuvius was filled almost to its margin with fluid lava covered by a solid crust, the whole resembling a pool of water whose surface has been frozen, and on which we were able to skate as on ice. We had not much difficulty in descending into the interior of the crater, and seated on a large block of lava, lying at ten feet from the small cone, we partook at our leisure of a cold fowl and a bottle of Capri.

On reaching the borders of this enclosure, we could perceive, notwithstanding the brightness of the day-light, that the lava in some of the fissures was tinged with a bright red colour; and we even perceived that some of the blocks were shaking, as if they were being moved by the action of an invisible hand. Occasionally, too, a hollow detonation was heard within the body of the mountain. During our dinner the flashes had become more numerous and vivid towards the eastern edge of the crater, at about fifty paces from us. It was evident that some crisis was at hand. The detonations which pealed forth from under our feet became louder and more

frequent; the scoriæ which were thrown up by the small volcano rose to a greater height, and in their fall they sometimes passed beyond the boundaries of the cone; the solid crust on which we were resting began to emit a crackling noise, and a few of the less steadily poised blocks were thrown over.

At this moment the soil began to rise at about forty feet from us, and in an hour's time, instead of presenting a nearly horizontal surface as it had done on our arrival, it formed, in the direction of the eastern margin of the crater, a rounded prominence of about ten or twelve feet in height. Several openings appeared on its side, but these were soon reduced to three, and finally to a single one, from which a perfectly fluid lava issued, and flowed in a straight line towards us. At its origin this burning stream was at most about four or five feet in width, and here it exhibited a beautiful and almost dazzling whiteness; but it gradually acquired a deep red colour as it also became considerably wider in the course of its progress. In about two hours' time it had reached the spot where we were standing, and we now began to retreat step by step before it. At the same time the entire crater seemed to waken into activity. All its fissures and crevices gleamed with light, and the block which had served us for a table began to grow red round its base. Every moment the heat grew more intense. It was a true overflowing, occasioned by the afflux of the liquid matters which rose from the abysses of the volcano. It was now necessary to think of retreating, for when we reached the margin, at least one sixth part of

this surface, which had previously been solid, was in a state of fusion; and it was evident that the blocks of lava on which we were standing, although they were still joined together, formed only a simple flooring, supported by this lake of fire, like a piece of ice which is still connected with the shore.

These appearances were indeed very different from those which precede the great eruptions of Etna. Nevertheless, the difference is more apparent than real. The phenomena are fundamentally the same, and differ only in the amount of their intensity. The small cone of forty feet serves, like the mountain of 10,000 feet, to give issue to the internal agent, and to eject flame, gases, smoke, sand, and scoriæ. Each ejection was accompanied by a noise proportionate to the energy of the subterranean fires. The stream of lava which was advancing towards us, at one time disturbed and overthrew solid blocks, which lay in its passage, and at other times upheaved and carried away with it the fragments of these masses, which floated on its surface like blocks of ice on a river which is breaking up.

It is evident that these *disturbances of the strata* and these *upheavals*, which we may actually observe in the crater of Vesuvius, must be reproduced on a much larger scale in all great eruptions generally, and in those of Etna more particularly. The central elevation and the terminal cone — which are formed of strata which have been upheaved and consequently broken at many points, and of moveable materials which are simply accumulated toge-

ther in masses — cannot possess any great stability. The sinking in, which is visible on the margins of the Piano del Lago and at other points, sufficiently proves how deficient in solidity is this kind of frame-work. When the subterranean furnaces are kindled and the rocks are fused, and an enormous quantity of gas liberated, an outlet must be obtained at some point or other. And if the crater is slow in opening, and the passages of communication should be closed, why should not the boiling lava raise up the vault which accidentally confines it in the same manner as the lava of Vesuvius, acting alone and without any shocks, upheaved before our eyes a hillock of several feet? *

The difference of thickness of the strata cannot be adduced in opposition to these conclusions. Is the earth's crust, on which we dwell, and in which the basins of our seas are hollowed out, in reality so solid as we are inclined to imagine? We will pause to consider this question.

Entire provinces have been gradually and continuously raised; as, for instance, a portion of Scandinavia. In other cases they have been suddenly elevated above the ordinary level, as was the case in 1822 with the territories of Valparaiso and Quintero. Considerable islands issuing from the bottom of the

* During the whole time that M. Blanchard and myself remained within the crater, that is to say, for more than three hours, we experienced nothing that resembled an earthquake. It was the absence of every indication of this convulsion which enabled us to enjoy entire security, and to observe without the least uneasiness the beautiful eruption which was so well adapted for a subject of study.

sea sometimes vanish as rapidly as they have appeared, as those islands of the seas of Iceland and the Azores which rise from the waves, eject flames and then sink into the abysses, from whence they had emerged; as, for instance, the Isle of Julia, which in 1831 rose in the Sicilian waters, although not a trace of it now remains; at other times, these islands become solidified and increase in number, as, for instance, in the case of Santorin, the Aleutian Islands, and the Azores, where in 1757 nine new islands were formed in less than a twelvemonth. At one place we find that in a single night plains have been upheaved, bristling with volcanic cones, as was the case at Mechoacham at the time of the formation of the volcano of Jorullo in 1759; while, in another place, we find that they are buried in the entrails of the globe, as, for instance, at Sorca, where forty villages disappeared with the land on which they stood. Mountains crumble away and are replaced by lakes, whilst others, on the contrary, rise from the earth, block up the course of rivers, or replace a bay by a cape. Earthquakes cause our fields to undulate, like an agitated sea overthrowing and engulfing our cities, and even at times shaking both hemispheres at once. We see therefore that everything teaches us that the crust which we call *terra firma*, in reality very little merits that title. We see how thin and fragile is that pellicle which envelopes the fluid part of our globe*, and we learn to understand

* A very erroneous idea is generally entertained in reference to

how rapidly it might be destroyed if a more or less free outlet to the action of subterranean fires was not always presented by the 559 volcanoes which are disturbed over its surface like so many safety valves.*

the thickness and solidity of the earth's crust. The following figures will furnish a more exact idea on this subject.

The most superficial strata of the soil participate in all the variations of temperature which depend upon the seasons, and this influence is exerted to a depth which, although it varies with the latitude, is never very considerable. Beyond this point, the temperature rises in proportion as we descend to greater depths, and it has been shown by numerous and often repeated experiments that the increase of temperature is on an average one degree (Fahrenheit) for about every 54·5 feet. Hence it results that at a depth of about 3,000 yards from the surface we should reach the temperature of boiling water. In supposing that the heat increases in a uniform ratio, we should have at a depth of twenty miles a temperature which would fuse most of the silicates that enter into the composition of our rocks; and at a depth of about twelve miles from the surface we should be on the verge of the incandescent mass which constitutes almost the whole of our globe.

Now this thickness, when compared with the dimensions of the earth, would represent about one inch for a globe whose diameter was about nine yards. In other terms, it would very nearly equal the thickness of a sheet of ordinary letter paper for one of those globes which are commonly used for geographical studies. With this illustration of the question before us, we cease to be astonished at the movements which can agitate this pellicle; and indeed if there is anything to excite our surprise it is rather that the habitable surface of our globe has not more frequently been the theatre of such convulsions, which, although they might be terrible in their results to ourselves, would not the less remain almost inappreciable on the vast extent of our planet.

* The following table gives the number and the geographical distribution of all the volcanoes and *solfataras* (semi-extinct volcanoes) whose existence has hitherto been verified.

Man is small and feeble, but full of pride, and he always takes himself as the unit, and as a term of comparison. He measures the globe and the universe by his own stature, and the infinite powers of nature by his own forces. In his eyes, Etna, that blow-hole which is scarcely perceptible upon our planet, which is about 24,000 miles in circumference, is a gigantic mountain, and he starts back in amazement at the forces which are required to upheave it. It is not very difficult, however, to convince oneself that in volcanic phenomena the energy of the cause is fully in harmony with the greatness of the effects..

Let us then, by way of illustration, inquire what relation exists between the forces employed at the present day by industrial science and those which slumber within the crater of Etna. Let us suppose, and the assumption is by no means an exaggerated one, that this crater is 500 yards in diameter, and that it penetrates below the earth to a depth equal to the height of the mountain.

The magnificent steam engines which exhaust the air on the atmospheric line of Saint-Germain, have a 400-horse power. They act under a pressure of six atmospheres, and their pistons present a surface of more than three square yards. In approximate calcu-

Parts of the World.	Volcanoes of Continents.	Volcanoes of Islands.	Total.
Europe	4	18	22
Asia	55	71	126
Africa	13	12	25
America	114	90	204
The Ocean	„	182	182
Total	186	373	559

(*Nouveau Cours élémentaire de Géologie*, by J.-J.-N. Huot.)

lations like this, the pressure of an atmosphere on a surface whose extent we know, may be regarded as equal to the weight of a column of water of the same base, and of eleven yards in height. Consequently the total effect produced by the machines of Saint-Germain may be represented by a weight of about 150 tons.

A column of water raised from the level of the sea to the summit of Etna, would exert a pressure of 300 atmospheres, but the fluid lava is very nearly three times heavier than water. Consequently when this lava flows over the margin of the terminal cone, its pressure at the level of the plain will equal a force of 900 atmospheres, while its force at the bottom of the crater itself will be equal to the pressure of 1,800 atmospheres. The weight of this pressure on every square yard of surface will therefore be equal to more than 40,000 tons.

Now we know that the pressure of liquids is exerted in all directions at once. Consequently each square yard of the vault which supports the volcano is subjected to a force, acting from below upwards, which is 283 times greater than that of the machines of Saint-Germain. In the crater alone, the total force which is solely employed in sustaining the column of lava at the level of the orifice is equal to 53,262,500 times that of these machines. This is a force of more than twenty-one thousands of millions of horses.

Hitherto we have supposed that the steam engine was in perfect working order, and that the lava rose easily to the margin of the crater. We know,

however, that this is not always the case. In the steam engine the safety valves become clogged, and are no longer available at the right moment; innumerable causes, some of which are still unknown, bring about the sudden evaporation of too large a quantity of water. In this case the boilers burst, and rending the most solid walls throw the fragments far around them. Under circumstances such as these, masses of fused metal weighing two tons have been projected to a distance of 250 yards. Now volcanoes have also their explosions, or, more correctly speaking, their eruptions are to a certain extent one continuous explosion, and the preceding remarks will show how extremely powerful must be their action.* To appreciate completely the forces which are put into action, it will be necessary to add to the pressures that we have already calculated the tumultuous liberation of vapours and gases, and the frightful degree of tension to which these elastic fluids must be subjected at a temperature capable of

* The following numerical details will afford some idea of the volcanic force. M. d'Aubuisson des Voisins estimates the velocity of the matters ejected at the mouth of the crater to be about 400 or 500 yards in a second. This is very nearly the velocity of a ball at the moment it leaves the cannon's mouth. On assuming that this velocity is only 200 yards per second, it has been found that, during certain eruptions, Vesuvius has thrown its artillery of rocks to a height of more than 4,000 feet. Estimates of height are, however, almost always very conjectural, and the volcanic force can be much better estimated by the space which is traversed horizontally. Now the volcano of Cotopaxi has ejected, to a distance of nine miles from its crater, blocks of ten cubic yards; that is to say, masses of rock weighing about 30 tons. From this we may judge of the force developed in the interior of the volcano.

liquefying the hardest rocks. It would be necessary to multiply the upward pressure resulting from these combined forces, not merely by the surface of the crater, but by the extent of the base, which may perhaps embrace the entire central elevation, and we should then obtain numbers representing a force of which nothing would be able to give us any adequate idea, if the mountain itself did not exist as a monument of this formidable power.

CHAP. VII.

THE BAY OF BISCAY.

BIARRITZ.—GUETTARY.—SAINT-JEAN-DE-LUZ.

Departure for the Bay of Biscay. — Bayonne. — The bar of the Adour.— Biarritz. — *La chambre d'amour.* — Geological problems relating to the age of neighbouring rocks. — Guettary. — Saint-Jean-de-Luz.— Encroachment of the sea. —Wearing away of the coast; the ground swell.— Hermellas.—Extreme variability in the type of the Annelids. —The Polyophthalmians; organic complication. — Realisation of some of the fables of mythology.— Independence of the nervous centres in certain of the lower animals; transposition of the ordinary seat of certain sensations.

THE early portion of June 1847 was a period of much enjoyment to me, for after a two years' unavoidable delay, I was at length enabled to resume my studies at the seaside; the Bay of Biscay being on this occasion the scene of my explorations. This expedition was almost like a voyage of discovery, for only one naturalist had preceded me in the zoological investigation of this portion of the coast of France. In 1794, M. Alexandre Brongniart had on different occasions visited the mouth of the Adour, and explored the neighbourhood of Biarritz. Being informed of my intentions, he placed his memoirs and notes most freely at my disposal. Although he was already then labouring under the disease to which he fell a victim a few months afterwards, M. Bron-

gniart * laid before me his diaries and the journals in which he had day by day recorded the varied events of his life. For two hours we perused together these memorials of the past, and often the voice of

* For more than a century the family of Brongniart has enjoyed the rare privilege of finding that the members of each new generation enhanced by their own eminent merit the splendour of the name which they bore.

Alexandre Théodore Brongniart, a member of the Institute, whose fame first rendered this family illustrious, was born in Paris in 1739, and died in the same city in 1815. Having been originally destined for the medical profession, he first directed his attention to scientific pursuits, but yielding soon to his taste for the fine arts, he devoted himself entirely to the study of architecture. We owe to him the erection of some of those princely mansions which are daily being replaced by the humbler houses of the bourgeois, and some of those parks which even more fully manifest the style of living in former times. M. Brongniart was engaged throughout the whole of his life in different public offices; he also erected many public edifices, among others the *Bourse*, the exterior of which was partly constructed in accordance with his plans, but on his death the completion of the work was entrusted to an architect who made very great alterations in the original designs.

Alexandre Brongniart, a member of the Institute, and professor at the Jardin des Plantes, was the son of Alexandre Théodore Brongniart. He was born in Paris in 1770, and died in the same city in 1847. From an early period he devoted himself to science, and at the age of twenty he published a work on the means of improving the art of enamelling. While he was attached to the Army of the Pyrenees, in the capacity of a military *pharmacien*, he devoted his attention specially to zoology, and commenced a memoir on the anatomy of Cephalopodous Molluscs, which, however, he abandoned as soon as he learned that Cuvier was engaged on the same subject. He next studied mineralogy, and published in this department of science a *Traité élémentaire*, which was adopted by the University, and was used in the mineralogical class at the Jardin des Plantes.

Brongniart having combined the study of living and fossil animals,

this aged philosopher grew strong, and his eyes glistened at the recollection of those days of his youth, when, as a humble *pharmacien* attached to the Army of the Pyrenees, he would wander forth at

published successively a treatise entitled *Essai d'une Classification naturelle des Reptiles*, the principal results of which have been universally adopted, and several important memoirs on fossil shells and crustaceans. It is to this last work that we must refer for his observations on the *Trilobites* —a family whose true nature he was the first to recognise, but which has since then been so much multiplied as to have become the subject of special treatises of considerable extent. At this epoch, Brongniart had become the *collaborateur* of Cuvier, and it is to their united efforts that we owe the work which was first published under the title of *Essai sur la Géographie minéralogique des environs de Paris* (1810), and two years afterwards under that of *Description géologique des environs de Paris* (1812). Subsequently Brongniart made a great number of geological expeditions, traversing every part of France, and a great portion of Europe, and he has fully established a claim to be regarded as one of the founders of modern geology.

These different labours did not, however, make him lose sight of a work on which he had been engaged for more than forty years. Having been nominated in 1807 to the directorship of the manufactory at Sèvres, he wished to bring the light of modern science to bear upon the manufacture of porcelain, and the results of his various investigations were incorporated in a work, entitled *Traité des Arts Céramiques*, which appeared only two years before his death.

M. Adolphe Brongniart, member of the Institute, and professor at the Jardin des Plantes, is the son of Alexandre Brongniart, and the worthy inheritor of his name. He first devoted his attention to botanical studies, for which he was prepared by his researches in minute anatomy and physiology. Among the works which he has published in this department of science, we may particularly instance his observations on the organisation of leaves and on the fecundation of plants; but M. Adolphe Brongniart owes more especially the high rank which he occupies in science to his researches on fossil plants. We may say that he is the founder of vegetable palæontology, as Cuvier was the founder of animal

dawn, provided with a piece of bread, which was to serve for his meal through the day. Exclusively absorbed in the studies which were to render his name illustrious, he was contented and happy if he could return at night with some fossil, some mollusc, or some alga, which he had gathered from the rocks on the shore, or in his wanderings along the sandy beach. M. Brongniart belonged to a generation which is daily passing away. All his life he had loved science for her own sake, and revered her under every form and every manifestation; he loved her too personified in those young and ardent students of nature who, like himself, had been zealously devoted to her cause, and he ever treated them not as rivals who were to be feared and shunned, but as successors who merited instruction and assistance.

A week after my interview with M. Brongniart, I was at Bayonne. In every other place I had always found a sort of separation between the water and the rest of the landscape, but here the country and the sea seemed to approach and blend with one another. Near its source the Adour, which is scarcely wider than the Seine at the *Pont des Arts*, winds along the foot of lofty hills. Near its mouth dunes covered here and there with pines*, appear

palæontology. Thus both departments of that new science of palæontology, which teaches us to read the history of the globe in its fossil remains, with as much certainty as we read the history of man on the monuments of the past, is of a wholly French origin.

* The kind of pine which grows near Bayonne is the *Pinus maritima*. This tree, whose trunk is often twisted, and whose wood is too soft to be of any great value, has nevertheless become a source

to bar its passage, while within the town itself, the trees of the public walks reach its very banks. Everywhere the black hulls of ships, their tall and slender masts, and their white or reddish sails, stand out against a back ground of verdure. One might almost suppose that one was viewing an inland lake, did not the rising tide indicate the vicinity of the ocean. Twice in the day the waters of the river are driven back, and the direction of the current changed, whilst the bridge of boats which connects Bayonne with its faubourgs as often rises and falls.

The Adour presents a somewhat singular phenomenon in the history of our rivers. At several different epochs its mouth has changed its place. The inhabitants of the district assert that it formerly flowed into the sea between Biarritz and Bidar, to the south of its present outlet, but an examination of the localities does not confirm this tradition. On the other hand, it is quite certain that at different periods this river has made an eruption towards the north. In 1360, the same tempest which destroyed the fleet of Edward III. off the coasts of Normandy, filled up the bed of the Adour and inundated Bayonne and the neighbouring districts. Harvests, cattle, merchandise—everything, in short, perished in the waves. At length the waters found an outlet near Cape Breton, and the river having formed for itself a new bed, fell into the sea at Vieux Boucaut, at

of riches to the whole of this district, from the great quantity of turpentine which it produces, and from the facility with which it grows on sandy dunes, which it consolidates, and whose further progress it arrests.

about twenty-four miles distance from its former mouth. For two centuries the Adour followed this direction, until, in 1579, Louis de Foix made a successful attempt to turn it back to its former bed. From this time forth, as in olden times, ships were able to come up to the harbour of Bayonne without the slightest difficulty; but it would appear that there was soon reason to fear new disasters. Under the continual action of the waves coming from the north-west, the channel, which had at first been tolerably direct, gradually inclined towards the south, and filled up the bed of the river with sand. In 1720, the channel had become almost impracticable. The river was now for the first time embanked, and from thenceforth additions were constantly being made to the magnificent dykes of Touros. The engineering difficulties were, however, far from being removed, and the bar of the Adour has always continued to be a somewhat perilous, and often an impracticable passage, notwithstanding the assistance which is afforded by a tug steamer that is always stationed here for the purpose of towing ships into the harbour. The bar of the Adour always presents the appearance of a restless and troubled sea. I have visited it during one of those splendid autumn days, when all nature seems to repose after the activity of the past season, and to prepare for the torpidity of winter. The breeze that was coming from the east was so slight that it did little more than stir the pennons that were hanging at the mastheads of the many vessels moored along either side of the river, and yet before I left the "Allées

Marines," those lovely walks which are singularly enough neglected by the Bayonnese for the ramparts of the town, I could hear that distant thundering crash which announces the vicinity of a stormy sea. The half clouded sun was gilding with its rays the whole town of Bayonne and its framework of hills, when I made my way along the narrow jetty of the left bank, which, although it seems a very feeble barrier against the power of the ocean, has hitherto proved sufficient to protect these sandy shores from being worn away. When I approached the village called Boucaut, the noise of the breakers was redoubled, and at the Quarantine house it became truly formidable. At length I reached the Signal tower, from whose platform I commanded a full view of the mouth of the river and its adjoining banks.

On either side the smooth and low beach sloped gradually upwards to the long line of sandy dunes, where many arid points rose above the plantations of pines, which were intended to fix the drifting soil. At my feet lay the low dykes which were planned by MM. de Prony and Sganzin, with a view of gradually contracting the bed of the river, and of acting as a means of flushing the sand and gravel. Before me lay the ocean, whose smooth surface was unruffled by the slight east wind that was then moving over its waters, and yet a broad semicircle of waves and foam separated the sea and the river. This was the bar of the Adour, and here was raging that storm which I had heard for more than an hour.

The tide was rising. Scarcely perceptible waves, which were flowing in from the ocean, rose by degrees as they came in contact with these low embankments, and fell into long undulations like extended lines of walls. Broken at their base by these breast-works, they were twisted upwards in coils, which rapidly descended in a shower of white foam and mist. Being soon again lifted up, not to an equal height, but with a greater force, they rose opposite to the Adour like a quadruple barrier, which was perpetually being destroyed and reproduced, until at length they reached the shore, where they broke with fury into a thousand foam-crested lines, dashing their long and rapid jets of white mist to the very top of the incline which had arrested their progress. At the mouth of the river they rushed precipitously through the narrow channel, dashing to the right and left against the jetties, as if they were endeavouring to open a broader passage for the waters of the ocean, and bearing with them in their course masses of yellowish foam, which looked at the distance almost like floating rocks.

Every stranger on arriving at Bayonne makes a point of visiting Biarritz, and as I was anxious not to depart from the ordinary custom, I lost no time in making inquiries as to the means of accomplishing this journey. Formerly this excursion was always made on the back of some animal, either a horse, mule, or donkey, on which was placed an apparatus very much like a set of double panniers, and this mode of travelling was called riding *en cacolet.* The traveller seated himself on the one side, while on

the opposite side of the animal, by way of balance, sat the *cacolettiera,* a sprightly black eyed Basque damsel of lively wit and quick repartee, whose engaging conversation no doubt contributed very materially to compensate the traveller for the length and weariness of the route.

The progress of civilisation, and the necessity of more rapid and frequent communications, have, however, put an end to these romantic journeyings. A tolerably good road now joins Biarritz to Bayonne. Various omnibuses and minibuses, decorated with the name of diligences, now carry on an active traffic, which is rendered more exciting by the competition of cabs and other carriages; but I have no doubt that many a traveller, when seated within these dusty and ill-adjusted vehicles, has often regretted the *cacolet* of former days. Nevertheless a journey to Biarritz is well worth an hour's exposure to dust and the jolting of a rough vehicle. This village is the very realisation of some lovely and picturesque scene in an opera. Imagine a small plateau terminating in a deep gorge, sloping rapidly towards the sea, and surrounded by mountains and rocks, interspersed with precipices and ravines; the whole scene being abrupt and wild, although on a very miniature scale; such was Biarritz before it became one of the most celebrated bathing places of southern France. Its two lines of hills advance into the sea in the form of a double-horned cape. To the left at the Pointe des Basques, begins a high range of cliffs, which stretch far towards the south, while to the right the Côte des Fous is dotted over

with the perforated rocks of the Attalaï, whose isolated pinnacles have been strangely fashioned into various shapes by the waves that are rapidly wearing them away. Between the Pointe des Basques and Attalaï lies Port-Vieux, from whence many whalers were wont to set sail year by year in former times, although the harbour, which is constantly being contracted, can now do little more than give shelter to a few stray fishing smacks. Encased as it were within this charming framework, lie the picturesque habitations of Biarritz. Some of the houses occupying the plateau and the bottom of the valley constitute the village and its principal street, whilst others are grouped here and there, by chance, as it were, and in accordance with the nature and character of the ground. The green blinds and dazzlingly white walls of these cottages, give them an air of cleanliness and comfort, which is well adapted to attract visitors, and each year the nomad population which flocks to Biarritz tends more and more to convert it into a fashionable watering-place, to the loss of the invalids who formerly resorted to it.

The coasts of the Bay of Biscay are extremely dangerous, even to the most skilful swimmers, except at a few sheltered spots. The Port-Vieux is, however, perfectly adapted for bathing, for it seems like a basin artificially formed by the hand of man for the very purpose. On either side, the two points of the cape break the force of the waves and neutralise the effect of the currents. The sandy bottom slopes gently upwards towards the shore, which is overlooked by the last houses of the village,

and a few of the principal establishments which have lately been erected for the accommodation of travellers. Narrow paths run in a zig-zag direction all round the harbour, and at the hour for bathing these walks are crowded with the promenaders, who for the moment have deserted the rocks of Attalaï, or the beach of Les Basques. Thanks to the patriarchal traditions of Biarritz, no artificial barrier separates the male and female bathers. Men and women here adopt a costume, to which the most scrupulous prudery could not object, but which varies somewhat according to individual taste, and thus conversations or even flirtations are as agreeably conducted in the bath as on the promenade. It afforded me no little pleasure to watch this scene of enjoyment and sport, in which harmless defiances were given and returned amid cries of joy and shouts of laughter. Every one is ambitious of outvying his neighbours, and even the most timid lady is desirous of reaching, at least once, the line which is slung across the entrance of the harbour. In order to attain this desired goal, most of the fair bathers are obliged to have recourse to the aid of some attendant cavalier, or to accept the less agreeable support of a rude swimming belt, composed of a pair of large gourds. I have, however, seen several daring lady swimmers, chiefly Basques or Spaniards, who, without the slightest apparent effort, would bring up a handful of gravel from a depth of ten feet, or would take a header with all the ease and security of a proficient swimmer.

At about a mile from Biarritz lies *la Chambre*

d'Amour, a deep recess hollowed out in a semicircle, and surrounded by inaccessible cliffs. The only access to it is by a narrow tongue of sand which is left dry by the retiring tide at the base of the northern cliffs. Formerly the shore was everywhere very low, and at high tides the waves beat the precipitous rocks of the bay in every direction, and sometimes penetrated into the grotto which had been excavated in the cliff. According to tradition it once served as the *rendez-vous* of two lovers. For a long time the ocean appears to have respected and protected their trysting place; but one day, when the waves were driven violently against the rocks by a strong north-west wind, the waters rose above their usual level, and the next day a fisherman, on penetrating into this rocky recess, found the bodies of the lovers clasped in each other's arms.

A similar catastrophe need no longer be apprehended. For many years past the repeated shock of the waves has crumbled away a portion of the cliffs, and the sand which has been washed in from the open sea has covered these *débris*, and obstructed the entrance to the grotto. At the present day, if the traveller were surprised by the tide and imprisoned within the Chambre d'Amour, the worst that could befall him would be imprisonment for a few hours in the open air, or perhaps, if the sea were running very high, he might be compelled to take refuge on the summit of the little hillock which covers the tomb of the two lovers.

The naturalist feels perhaps even a greater interest than the poet in the Chambre d'Amour, for the un-

dulation of the soil surrounding it marks the extreme boundary of the chain of the Pyrenees. At a few feet from this little bay, the cliffs sink to rise no more, their last rocks dipping below the sea of sand, which extends as far as La Gironde, exhibiting in the midst of our richest provinces a miniature representation of an African desert. Biarritz, with the surrounding district, which is thus situated on the limit of one of those great geological formations which give to our globe its existing configuration, presents very curious problems, regarding whose solution geologists are by no means agreed. We will endeavour to give some idea of this subject, by taking for our guides the magnificent Atlas* and the special Memoirs of MM. Dufrénoy † and Elie de Beaumont.

* In 1811, M. Brochant de Villiers, professor of mineralogy and geology at the School of Mines, first proposed to construct a geological atlas of France. The execution of this project, after many delays, was resumed in 1822, under MM. Dufrénoy and Elie de Beaumont, who shared in the responsibility and labours of the undertaking. They devoted themselves for nineteen years to this great work, which appeared in 1841. It is unfortunately very difficult to procure copies of this splendid atlas, in consequence of the government having reserved to themselves the absolute monopoly of the work.

† M. Dufrénoy a member of the Institute, professor at the Jardin des Plantes, and Director of the École des Mines, has raised himself to the first place among contemporary geologists by the publication of numerous works, among which we will only instance those which refer to the geological atlas of France and to Mount Vesuvius, the latter of which is to a certain degree the pendant to that of M. Elie de Beaumont on Etna. M. Dufrénoy has especially endeavoured to restore to mineralogy its character as a science of observation, which it had partly lost by the introduction of almost exclusively chemical methods. His *Traité de Minéralogie*, which is

It is well known that our globe has only gradually attained its present configuration. Before it presented the elevations and depressions which are now figured on our geographical maps, its surface underwent numerous convulsions which were separated from one another by long intervals of repose. During these periods of rest, whole tracts of land were heaped up upon one another, and strata superposed on other strata at the bottom of the vast seas of those geological periods, but when the moment of a new cataclysm arrived, the forces which had been temporarily dormant in the centre of the globe were again awakened, and thrusting the subjacent rocks through more recent deposits, caused hitherto submerged continents and new chains of mountains to be upheaved. Vast dislocations, twistings, ruptures, and disturbances of strata accompanied each of these upheavals, and it is from these disturbed masses, and the relations by which they are connected, that modern science has succeeded in tracing, with an almost incredible degree of certainty, the history of these vast revolutions.

At the period when the land surrounding the Bay of Biscay first appeared, Europe generally, and France more especially, bore no resemblance to their present condition. Twelve upheavals or cataclysms had already taken place.* Auvergne, the

accompanied by a magnificent atlas, has become a standard work on the subject to which it refers.

* These numbers have been given by M. Elie de Beaumont in one of his recent publications on the subject. Article SYSTÈMES DE MONTAGNES in the *Dictionnaire Universel d'Histoire Naturelle.*

We ought however, to observe that the author himself merely

Black Mountain, and the Cevennes formed a sort of continent, which extended as far as the Ardennes and the Vosges; Brittany, a portion of Normandy, Maine, and La Vendée were prolonged into a sort of irregular isthmus, and were connected by Poitou with this central plateau, while Flanders, Picardy, Champagne, the Paris basin, Upper Normandy, Touraine, the south of France, and the north of Spain were all one vast sea, in the midst of which rose a few scattered islands. At the bottom of this sea were deposited the last strata of the secondary or cretaceous formations, which by their thickness and variety attest the long period during which this condition of things must have existed.

This state of repose was disturbed for the first time by the thirteenth upheaval, namely, that of Mont Viso, which gave origin to the French Alps. Then, after another period of tranquillity, came the fourteenth cataclysm, which was one of the most considerable of which we have any traces on the earth's surface. It extended from the western extremity of Europe as far as North America, through the whole of Asia; and it is especially to this upheaval that the Pyrenees owe their present elevation.* The eruption of the primary rocks which

regards these numbers as provisional, and as representing only the present condition of science. No one could be less disposed than M. Elie de Beaumont to assign impassable limits to the progress of knowledge, and on this account he has always designated every recognised upheaval by a name, borrowed either from the principal chains which have resulted from it, or from the districts in which it has occurred.

* The present form of mountain chains is not owing to a single

formed the central axis of these mountains, uplifted the chalk strata of which we have just spoken. On either side of this chain we find that the strata are inclined in a direction parallel to this axis, and they constitute all the littoral rocks of the Basque provinces.

If the geological phenomena that occurred round the Bay of Biscay had stopped at this epoch, their explanation would have presented very slight difficulties; but such is by no means the case. The chalk strata which have been raised and thrust to the south by the appearance of the Pyrenees, and retained towards the north by the ancient formations on which they rested, had been bent in the middle, and hollowed into a vast depression, which had been immediately filled up by the waves. The Pyrenees were thus separated from France by a broad arm of the sea, which extended to the west from Biarritz to La Gironde, and to the east from Carcassonne to the mouth of the Rhone. Tertiary strata were successively deposited in this basin, and many distinguished geologists, guided principally by the study of the fossils of the district, have referred the neighbourhood of Biarritz from the Chambre d'Amour to

upheaval. M. de Beaumont admits that the Alps, such as we see them in the present day, have been as it were modelled by at least five upheavals, and the Vosges by as many as twelve. According to M. Durocher we find in the Pyrenees superposed traces of seven successive cataclysms. Often, in a somewhat limited space, different systems of mountains, differing in age and direction, appear to have been accumulated, as it were at will. Thus MM. Boblaye and Virlet recognised in the Morea as many as nine distinct upheavals. Article SYSTÈMES DE MONTAGNES.

the Mill of Sopite to these formations. In accordance with this view, the Pyrenees must have been upheaved subsequently to the formation of these strata; and consequently they would be *more recent* than has generally been supposed.*

A special circumstance complicates the question and renders its solution still more difficult. Very long after the appearance of the Pyrenees, and after the deposition of the tertiary strata, a new cataclysm occurred which convulsed the whole region, changing the primary inclination of the strata, and occasionally modifying their relations to one another. Serpentine, a kind of porphyritic rock, penetrated through all the preceding formations, and gave rise at several points to *centres of partial upheaval.* M. Dufrénoy had drawn attention to this remarkable fact, and he made a sketch of one of these masses of serpentine surrounded by gypsum, which had exerted an upheaving action on the cliffs lying between Biarritz and Bidar.†

I did not fail to visit this remarkable locality; but twenty years had passed since M. Dufrénoy had made the sketch which accompanies his memoir, and the aspect of the district had been strangely changed since that time. The gypsum had almost entirely

* Among those geologists who have maintained this opinion, we must especially mention M. d'Archiac, who amongst other works has published a very important memoir on the fossils of Biarritz (*Mémoires de la Société géologique de France*, 1846), and M. Alcide d'Orbigny, a geologist who has most strenuously maintained the principle of the characterisation of strata by fossils.

† *Mémoires pour servir à une description géologique de la France*, by MM. Dufrénoy and Elie de Beaumont, t. ii. pl. 7.

disappeared under the incessant action of the waves, and the cliffs had retreated at least 150 feet farther inland. The serpentine, from its extreme hardness, had alone been able to resist this continued action of the waters, and it now stood forth in the midst of the beach as an evidence of the destructive power of the waves. M. de Collegno, who had made his observations long before my visit, estimates the annual encroachment of the sea to be about ten feet.*

This fact, which is observable in a more or less marked degree along the whole length of the coast, depends upon the very nature and structure of the rocks. The cliffs here are generally formed of a marly or sandy limestone, which becomes disintegrated under the action of atmospheric agents. It is almost everywhere divided into laminæ, which are occasionally separated by layers of clay. This earth on being carried away by the waters becomes changed into a sort of foliaceous crust, which yields to the slightest shock of the waves; and, indeed, from the Chambre d'Amour as far as the bay of Saint-Jean-de-Luz the whole line of the shore affords ample proof of a gradual and progressive disintegration. On every side deep crevices, crumbling earth, and

* *Bulletin de la Société géologique de France*, 1839. M. de Collegno, being implicated in the political troubles of Piedmont, was obliged to leave his country. He learned, however, to seek consolation for the pains of exile in the pursuits of science, and during his residence in France he was appointed professor in the Faculty of Sciences at Bordeaux. Having been subsequently recalled to his native country, he continued to take an active and earnest part in politics, and he even returned to Paris as the representative of the country from which he had once been banished.

recently fractured rocks, meet the eye. Science alone can profit by a state of things which threatens the future stability of these districts. The rent and fractured sides of the cliffs bring to view innumerable fossils, the remains of those animal and vegetable races which once peopled these ancient seas, and every storm prepares a new harvest for the naturalist. In order to avail myself of this opportunity, I lost no time in providing myself with a geologist's hammer and a quarryman's chisel, and thus equipped, I was enabled, under the direction of the experienced guide * who accompanied me on my explorations, to make a large collection of fossils in the course of a very few days.

Biarritz, therefore, presents sufficient attractions for the tourist and the geologist, but it is not equally favourable to the pursuits of the zoologist. The rocks of la Pointe, which are isolated between two long tracts of sandy beach incessantly worn by the waves, afford a very precarious and limited retreat to marine animals. Indeed, some small Molluscs, now and then an Annelid, and a few of the commonest Zoophytes are the sole representatives of their fauna. I saw, therefore, that it would be mere loss of time to remain longer at this station, and after consulting M. Beautemps-Beaupré's Atlas, I determined to fix my quarters at the little village of Guettary, which is situated about six miles from the town of Saint-Jean-de-Luz.

Guettary, which is a true type of a Basque vil-

* M. Darrac of Bayonne, who is well known to all naturalists who have visited this part of France.

lage, consists of a church, round which are grouped ten or a dozen white houses furnished with red or green blinds, and perhaps some fifty similar habitations scattered over a space of about two square miles, and enclosing within its limits several low hills and small valleys, dotted over with clumps of trees, and corn, and maize fields, which are everywhere intersected by narrow paths, shaded by hawthorn and wild plum trees. The cliffs, which are broken by a sort of platform at about the elevation of one of the principal groups of houses, sinks in a rapid slope towards a small sandy harbour, which is protected by two long ledges of rocks, which extend on either side of it like natural jetties. On this account Guettary is also well adapted for bathing, and the cheapness of provisions, and the quiet and isolation of the village, attract to it many of those who dread being involved in the luxurious habits of Biarritz, and who visit the sea rather for purposes of health than pleasure. The primitive simplicity and customs of the olden times still prevail at Guettary, where the bathing is carried on in the most social and familiar manner. The beach, which is exposed to the sea, receives the full force of the waves, which often roll in with considerable violence. For the sake of making a better stand against the onset of the breakers as they dash against the shore, it is customary for the lady bathers, both young and old, to advance hand in hand into the water; and it is truly a pleasant sight to watch the sort of joyous anxiety with which they await the arrival of the waves, each one springing aside to avoid the ad-

vancing mass of waters, although occasionally disappearing almost entirely under some high wave. There is not, however, the slightest cause of alarm on these occasions, nor is any real danger to the fair bathers to be apprehended, for a master diver, an old sailor, who has been bronzed by exposure to the sun and winds in every climate, is always present to watch over the general safety, and to afford assistance in case of need. There is, however, no instance on record of any bather having been drowned at Guettary, and there is no doubt that bathing in this manner in the open sea must be doubly efficacious from the amount of exercise which it necessitates.

All the men of Guettary are sailors, or, at all events, lead a seafaring life. The greater number of them generally ship themselves on board vessels bound for Newfoundland, and after the season they return to their homes with a sum of money varying from 800 to 1,500 francs each. The others are engaged in fishing, more especially in the tunny fishery; but this is not conducted here in the same manner as in the Mediterranean, for the abysses, rocks, and tempests of the Bay of Biscay do not allow of the establishment of *madraguas*.

The fish too is different in the two seas. The tunny of the Mediterranean may be known by its short pectoral fins, but the species which is caught at Guettary has very long fins, and is, moreover, of much smaller size, although its flesh is more delicate, and hence it is most esteemed in a commercial point

of view.* The fishermen, who pursue the tunny to a distance of from sixty to ninety miles off the shore, use long handlines baited with a piece of canvas roughly painted so as to resemble a sardine. It requires all the proverbial intrepidity of the Basque sailor to venture out to such great distances in small undecked boats, and that upon a sea which is surrounded on every side by this formidable *iron-bound coast*, which is certain destruction to every ship that strikes upon it; but when the fishing is good the profits are very considerable. I have seen one of these boats return to Guettary loaded with more than eighty tunnies, weighing on an average more than thirty pounds each. In their cruise of two days, the crew, consisting of five men and a boy, had gained more than 1,000 francs. The Newfoundland trade together with the Tunny and Sardine fisheries (the latter of which is more especially practised by the fishermen of the Socoa) is quite sufficient to diffuse plenty, and even riches, among the population of this coast. My landlord at Guettary was a striking instance of what may be done here by order and economy. At the age of twenty, Cazavan was a common sailor, poor, and with no prospect of advancement. He then married a woman as poor as himself, and immediately afterwards sailed for New-

* This difference in the length of the fins joined to several other characteristics has led to the separation into two distinct genera of these two fishes, which we have designated in the text by their ordinary appellation. That which is caught in the Mediterranean is the only true Tunny, the *Thynnus Mediterraneus* of naturalists. The other is the *Orcynus ala longa*.

foundland. At the present day he is a landowner, and one of the first master sailmakers of Bayonne. Unhappily, however, his case is an honourable exception to the general rule, for recklessness and dissipation keep up a constant state of poverty amongst this population, which might so easily attain to a state of competence; and strangely enough it is to the women more especially that this sad result is to be attributed. Surrounded by sailors, they seem to have adopted their character and manners. The greater number give themselves up to drinking, and when the father or sons return from some distant cruise, there is always a bread or tavern bill to be paid for with their earnings. The little that remains from their wages is soon dissipated in the same manner. It is thus that Guettary, which of itself sends forth more than 200 men to the cod fisheries, and which consequently receives annually from this sole branch of commerce from 200,000 to 250,000 francs in hard money, suffers misery notwithstanding this source of wealth, which would rapidly enrich the neighbouring communities. There is certainly no doubt that the Basques of the plain and of the mountains are very different in this respect from their brothers of the coast, and it is very easy at comparatively short distances to obtain striking evidences of the moralising influence of agricultural pursuits.

To the right of the little harbour of which I have already spoken, extends the sandy beach which connects Guettary, Bidar and Biarritz. To the left begin the rocks which run along the base of the cliffs to the very mouth of the Bidassoa, and are un-

covered at every tide. This was the field of my operations, and I certainly found it very hard ground to work upon. The chalk rocks, which have been incessantly broken by the waves, are worn down to the level of high water, forming a sort of irregular causeway, which extends to a width of several hundred yards. The strata, which have been bent and twisted in all directions like the leaves of a book that had been purposely crumpled, form a coast line bristling with points and narrow ledges, and intersected to a greater extent than I had ever observed with openings and fissures.

In the midst of this disorder there was no vegetation, and no mud suitable to the abode of marine animals, or adapted to their nourishment. On every side lay pure sand, which was consequently unsuited to animal life, or solid rocks, which showed between their laminæ the various creatures which I was anxious to obtain to aid me in my zoological inquiries. An ordinary pickaxe would have been of very little use to me here; but, knowing the nature of the ground, I had provided myself with a very strong spade, tipped with steel and terminated below by a sharp point, and with this instrument I attacked the foliaceous laminæ of the compact limestone, which was frequently superposed on quartz. Besides this I had a hammer, and by the help of these tools my flasks and bottles were soon tolerably well filled. However, both here and at Biarritz, no less than at Saint-Jean-de-Luz and at Saint Sebastian, I missed that superabundance of marine animals to which I had been accustomed in my former excursions. The

coasts of the Channel, which perhaps are exceptional in this respect, had spoiled me for the Bay of Biscay. Guettary then had become my head-quarters for the time being. Sometimes I explored the neighbourhood, intent on zoological investigations; at other times I visited the cliffs of Bidar, provided with a large canvas bag, which was very soon filled with vegetable treasures, or with some fossil molluscs or zoophytes, intended for the Museum of the Jardin des Plantes. On several occasions I extended my excursions as far as the fort of the Socoa, which is situated at the southern extremity of Saint-Jean-de-Luz, and, the better to profit by my distant explorations, I usually carried with me a double supply of collecting apparatus. On these occasions I was equipped somewhat after the Robinson Crusoe fashion. At my right shoulder hung a bag for fossils; over my left arm was suspended a long tin box intended to receive large animals. My hammer was passed through a belt somewhat in the fashion of a poignard, whilst my tubes and bottles, whose wide mouths protruded from all my pockets, personated inoffensive cartridge boxes, or very harmless pistols. My double pickaxe with its strong ash handle completed my strange equipment, and no doubt made me appear a most singular object; indeed the fishermen and labourers, on seeing me pass, regarded me with a look of the most intense curiosity, whilst more than once I was pursued by the entire juvenile population of Saint-Jean-de-Luz.

This town, which is the last on this frontier of France, has more than one claim to the notice of the

traveller. Its roadstead, which affords the only safe anchorage along the whole line of coast from the Gironde to the Bidassoa, presents a view which challenges admiration from those who have seen the Gulf of Palermo and the Bay of Naples. All that is lovely or stern in the characteristics of Basque scenery is concentrated in this view. From the summit of Point Saint Barbara, whose batteries, which are now in ruins, formerly exchanged fire with those of Fort Socoa, the eye in turning towards the south, encounters a line of rounded hills, irregularly interspersed with trees and small white-washed cottages. To the east, the bay expands into a semicircle, margined at its base by the houses of Saint-Jean-de-Luz, which, seen from a distance, has all the appearance of a large town. A narrow opening, contracted between two granite dykes, marks the entrance of the harbour and the mouth of the Nivelle. Beyond, this little river flows through a charming valley, which is overhung by the abrupt declivities and barren summit of the Rune; to the west, the bay curves into a crescent, and gliding below a triple series of hills terminates at the large grey tower of the Socoa. On every side, the Pyrenees exhibit their deep gorges and rugged rocks, whose outlines are softened by distance, their picturesquely indented summits gradually vanishing in the direction of the coasts of Spain, until they are lost in the horizon, amid the double azure of the sea and sky.

Saint-Jean-de-Luz contains now only about 2,000 inhabitants, but in its days of prosperity it numbered

a population of fully 10,000. Its seamen had for a long time no rivals in the whale and cod fisheries; and, as late as the middle of the last century, it enjoyed a state of the greatest commercial prosperity. Louis XIV. and the Spanish Infanta received the nuptial benediction in the principal church of Saint-Jean-de-Luz, and this event is still referred to with considerable pride by the inhabitants. Elated at the honour of having lodged the king within their walls*, whilst his suite and equipages remained at Bayonne, they contemptuously designate this latter town as the *stables of Saint-Jean-de-Luz*. This, however, must be but a mournful source of consolation; for the real struggle, which once existed between these two towns, has for many years past been a mere tradition, and Bayonne has nothing now to fear from her old rival. The ocean even seems to have taken part with her, and every year this formidable auxiliary is carrying away, piece by piece, some fragment of Saint-Jean-de-Luz.

This is no exaggeration, for I simply express a fact which is but too evident. If you go to the rocks which form the left bank of the mouth of the Nivelle, you will everywhere see traces of foundations and a few fragments of broken walls; yet this was once one of the ancient quarters of the town. If you proceed along the sandy beach at the foot of the bay, you will find at fifty feet or more in advance

* The inhabitants of the district always speak of this event as if it were an occurrence of a very recent date. They never refer to this king as Louis XIV., but they always speak of him as *le roi*.

of the present pier a circle of mason work, which is the only trace now existing of a well which in 1820 watered the gardens which lay at the back of a street of which not a vestige now remains. If you return to the town, you will find, behind the mole which is intended to protect it, uninhabited houses, falling in and crumbling to pieces in consequence of neglect. This state of things is owing to the long and cruel experience which has taught the inhabitants that all means of defence against the enemy which is thundering at their gates are alike unavailing, and that the wisest and safest plan is to retreat before its advances.

Saint-Jean-de-Luz formerly possessed natural dykes of its own. The entrance of the bay was narrower, and while a ledge of rocks served the purpose of a breakwater, the mouth of the Nivelle was as it were embanked between the mountain of Bordagain and a high tract of sandy dunes. Towards the seventeenth century, the Points of Socoa and of Saint Barbara yielded little by little, the plateau of Arta sank more and more, and the waves, which were then able to reach the beach without any serious obstacle, began to wear it away. A wall was now constructed to stop their further advance, but the sea encroached daily more and more upon the land, and on the 22nd of February, 1749, a tempest carried away this first dyke, together with several houses.

Since this time the most skilful engineers have vainly attempted to struggle against the fatality which seems to be impending over Saint-Jean-de-Luz. Works which to all appearance were of the most

solid kind have been thrown down, and their complete destruction by the storms of 1822 appears definitely to prove the inutility of all further attempts. In the hope of opposing the advance of the waves, M. de Baudres improved upon the works of his predecessors, and in the additions which he made to the former embankments he appears to have exhausted all the resources of engineering art. A dyke of earthwork was erected on the embankments formed by the sea itself, and strengthened in the interior by massive supports of masonry. With a view of offering the greatest opposition to the force of the waves, its exterior was covered by a steeply inclined wall of a yard in thickness, composed of large blocks of freestone. Enormous masses of rock bound down by three tiers of deeply sunken piles protected the base of the dyke, and yet in the course of a few days the piles were all torn up, the pieces of rock washed away, and the whole so entirely destroyed, that after the tempest there remained not a single vestige of the embankment for a length of more than 140 yards.* The ocean had passed its levelling touch over the whole of the ruins which it had made, and entombed them in a bed of sand.

A new pier has now replaced those which the sea had destroyed, but we scarcely dare to hope that it will be able to afford better resistance than its predecessors. The sand has already begun to accumulate at its base, and with every storm of wind the waves pass over it, and break into the town, carrying masses of sand and gravel with them through the streets.

* *Nouveau Cours élémentaire de Géologie*, by M. J.-J.-N. Huot.

To save Saint-Jean-de-Luz by any direct means of defence would, therefore, appear to be impossible, and experience seems to show that a more successful result would hardly be attained by attempting to defend it by a line of advanced works. Vauban proposed to close the bay by means of two moles which, resting upon the rocks of Saint Barbara and Point Socoa, would have left only a very narrow passage between them. Towards the end of the last century an attempt seems to have been made to put this plan into execution, but after several fruitless trials it was found necessary to relinquish the project. The dyke of Saint Barbara, which had been advanced about two hundred yards, is now entirely abandoned, while that of the Socoa has been adapted to a wholly local purpose, and now merely serves to protect the fort with a small harbour adjoining it. Thus Saint-Jean-de-Luz, or at least all the portion of the town which separates the bay from the harbour, is irretrievably doomed to destruction.

Such was already the opinion of Napoleon when he visited the town, and far from thinking it expedient to pursue this struggle with the ocean, he rather wished to yield to it at certain points in order the better at others to avail himself of its power. According to the plans which were drawn up under his own immediate direction, the town was to be destroyed as far inland as the church, by which a free passage would be opened to the sea in the direction of the low and shallow land, through which the Nivelle takes its course. A harbour dug out behind the mountain of Siboure would have afforded safe shelter

to shipping, and, finally, for nothing checked this genius who delighted in colossal schemes, the Adour was to have been diverted from its present bed, and its waters turned into the new roadstead, which would thus have been kept free from sand. It remains for engineers to determine whether so desirable a project, which would have afforded to our coasts a harbour of refuge, which they so greatly need, is practicable and deserves to be put into execution.

One cannot contemplate the devastation which has been caused by the sea along the whole line of this coast, and more especially at Saint-Jean-de-Luz, without inquiring to what special cause we must attribute this destructive action of the ocean. A very simple experiment will suffice to solve this problem. If we take an inverted funnel and plunge it rapidly into a vessel filled with water, taking care not to submerge the mouth, we shall perceive at every movement the liquid will rise within the funnel very much above the external level, darting upwards in a jet through the orifice. If the funnel remain motionless, and we let the vessel of water be rapidly moved from below upwards, a precisely similar result will be brought about.

The Bay of Biscay, which is formed by the union of the coasts of France and Spain, which intersect one another almost at right angles, forms a sort of gigantic funnel whose base opens towards the north-west. Besides this, the coast dips into the sea on almost every part of the bay below slopes which become more and more steep in proportion as we advance towards the bottom of the bay, whilst the

depth of the water at a short distance from the shore increases in a similar proportion. Thus the waves, urged by the north-west wind, traverse the whole of the Atlantic as far as the entrance to the Bay of Biscay without having encountered any obstacle to their course. But being now compressed between coasts, which gradually approximate more and more closely to one another, they exhibit on a large scale the same phenomenon as the water in the funnel, and flow towards the bottom with a constantly increasing velocity. It is only at short distances from the shore that the deep waves striking against the submarine escarpments tend to shoot upwards in an eddying current, like those which we observe to be formed at the water's level along our dykes; but having been stopped and turned aside by the strata of water which cover them, these ascending currents become changed into a *ground swell*, which moves with frightful rapidity and strikes against the shore with an irresistible force. During the storm of 1822 the waves which were dashed from the rocks of Arta had a breadth of more than 400 yards, and moved at the rate of twenty yards a second. Their progress was therefore nearly twice as rapid as that of a locomotive which is going at the rate of thirty miles an hour.

According to Colonel Émy, the ground swell plays a very considerable part in the greater number of the remarkable phenomena exhibited by the ocean.*

* *Du mouvement des ondes et des travaux hydrauliques maritimes*, by Colonel Émy. M. de Caligny, who is well known in the scientific world for his able experiments on hydraulics, has opposed

It occurs in all seas, but the disposition of the coast-line influences its intensity. It is by this ground swell and not by the superficial waves that boulders, pebbles, sand, and all submerged objects are thrown on the shore, and this is also the cause of those breakers occurring above submarine shoals, which are so much dreaded by sailors, and which render many channels impracticable even during the calmest weather, as we see amongst other places at the entrance to the bay of Saint-Jean-de-Luz. To the same kind of ground swell we must also ascribe that perpetual tempest which seems to prevail at the bar of the Adour, and at several other points of this coast. Colonel Émy also refers to it the singular phenomenon which I have observed on a small scale in the river of St. Sebastian, but which is much more fully developed in almost all large rivers. It is known to the English by the name of the *bore*, to the bargemên of the Seine as *la barre*, to those of the Dordogne as *le mascaret*, and to the boatmen of the Amazon as *la pororoca*. At the mouth of the latter river, during spring tides at the periods of new and full moon, the sea, instead of continuing to rise for six hours, attains its greatest elevation in

the theory of Colonel Émy in relation to the formation of the ground swell, and he regards it as owing to the action of waves, which are formed not by simple undulations, but by a real transportation of liquid. All the effects attributed to the ground swell are ascribed by him to the back stroke.

The views which we have here expressed correspond very nearly with those of M. de Caligny, although we agree with Colonel Émy in attributing a very decided influence to submarine rocks in the formation of the ground swell.

the course of two or three minutes. A wave of twelve or fifteen feet in height extends across the entire breadth of the river. This is very soon followed by two or three similar waves, all of which ascend the stream with a terrific noise, and with such rapidity that they destroy every thing that opposes their passage, uprooting trees and carrying away vast tracts of land. The *pororoca* extends its influence sometimes as far as 600 miles inland. In the open sea, the ground swell is not the less powerful where it encounters sharp and perpendicular rocks in its passage. These ground waves have often been known to dart their eddying lines of water to the very top of Lot's Wife; a rock which is situated in the Archipelago of the Philippines, and which rises to an elevation of more than 360 feet. Colonel Émy asserts that these waves act at a depth of 130 yards, and that they will raise above the level of the sea columns of water more than 50 yards in height, of 2,000 or 3,000 cubic yards in bulk, and weighing from 2,000 to 3,000 tons. With such figures as these before us, we can no longer feel surprised at the ravages which these waves have committed at Saint-Jean-de-Luz, and we may now more readily believe in the possibility of blocks of stone which weighed four tons, and formed part of the masonry of the pier, having been uplifted and carried to the top of the dyke.

It is also in a great measure to this ground swell that we must attribute the relative poverty of the coasts of Guettary, Saint-Jean-de-Luz, and Saint Sebastian in respect to marine animals. These

laminated rocks are so constantly penetrated by the waves to their very innermost fissures and indentations that they cannot nourish a very numerous population; but as the animals which live in these recesses belong to a warmer sea than the Channel, they were to a certain extent new to me, and on this account they were the more highly valued. It must, moreover, be remembered that in the present state of science no real interest can attach itself to superficial studies embracing a very large number of animals. A single species thoroughly and systematically studied will teach more than a hundred that have been cursorily examined. The great matter, however, is to make a judicious choice, and in this respect I was very fortunately situated. At Guettary I found an abundance of those Polyophthalmians which I had already studied in Sicily together with the same Hermellas which I had casually seen at Granville. These two types were represented here by species which differed from those with which I was already acquainted. I lost no time in testing my past researches by a new and severe revision, while at the same time I entered upon fresh inquiries, and the results of these investigations, of which I shall endeavour to give some idea, fully recompense me for all my labours.

On these coasts, which are so violently beaten by the waves, we often observe small hillocks of sand pierced by an infinite number of minute openings half covered by a thin projecting margin. These mounds are either found behind some large rock or in some deep fissure, although occasionally they are

fixed on an entirely uncovered point. These little hillocks or mounds which look very much like a thick piece of honeycomb are in reality villages or populous cities, in which live in modest seclusion certain tubicolous Annelids, known by the name of Hermellas — creatures as curious as any that fall under the notice of the naturalist. Their body, which is about two inches in length, is terminated anteriorly by a bifurcated head, bearing a double bright golden-coloured crown of strong, sharp, serrated silken threads.* These brilliant crowns are not mere ornaments, but, to speak more correctly, are the two sides of a solid door or rather a true portcullis, which hermetically closes the entrance of the habitation, when, at the least alarm of danger, the Annelid darts with the rapidity of lightning within its house of sand. From the edges of the cephalic opening, issue about fifty or sixty light violet-coloured slender filaments, which are incessantly moving about like numerous minute serpents. These are so many arms which can be lengthened or shortened at will, and which seizing the prey as it passes, bring it into the hollow funnel-shaped mouth at the base of the depression. It is by means of these arms that one by one the grains of quartz or hard limestone are collected, and put into their proper places, to serve in the composition of the tubes, the different parts being solidly cemented together by a sort of mortar-like mucosity, which is furnished by the animal itself. On the sides of its

* These Setæ replace the calcareous or horny operculum, which in the ordinary Tubicula, similarly serves to close the orifice of the tube.

body appear little projections, from whence issue bundles of sharp and cutting lances or broad fans, serrated like semicircular saws. These are the feet of the Hermella. Finally, the back is furnished with cirrhi, recurved like sickles, and whose colour varies from dark red to grass green; these organs represent the branchiæ, which, by an exception that has hitherto been found to be unique in this group, are distributed over every ring instead of being united to the head like the petals of a flower.

These external characters are in themselves sufficient to attract the attention of the naturalist to the Hermellas, and most keenly to excite his curiosity. Their internal organisation is not less remarkable. These singular animals realise in their actual anatomical details a theoretical view which might hitherto have been justly regarded as a mere abstract idea.

In the Articulata generally, the two sides of the body are similar to one another, so that these animals may be regarded as formed by the reunion of two symmetrical halves, cemented together along the median line, and attempts were long since made to confirm this view by the study of their embryology; and Newport, one of the most distinguished comparative anatomists of England, had shown that in the young Myriapods *, the abdominal nervous centres, the *ganglia*, are developed in two halves, which become subsequently united. I had made a similar observation in respect to a *Eunice sanguinea*, which

* This class is nearly allied to that of insects, and it includes amongst others the Centipedes and Millipedes.

was in the act of producing the posterior segments of the body, which had been lost by some accident, but no adult animal had hitherto been met with which presented any very apparent traces of this original division. In the Hermella, however, this division exists throughout the greater portion of the body. Throughout the whole length of the abdomen, the muscles, vessels, and nerves are all double, and the two halves are only held together by the skin and by the digestive canal, which is single. Here, then, the Annelid is actually cleft in two; both before and behind all parts of the muscular and vascular apparatus meet along the middle of the body, but the ventral nervous system remains divided from the one extremity to the other, and its two halves only communicate together by delicate threads or excessively thin bands.*

At the period when I made these observations, this division of the nervous system in the Hermellas was regarded as an entirely exceptional mode of arrangement; but in the course of my investigations I found that the Annelids exhibited many other equally remarkable phenomena. This is incontestably the most interesting group to which the zoologist can at the present day devote his attention; for it appears to be

* I would here observe, that in the Articulata the principal nervous centre is situated in the head *above* the digestive tube. This ganglion is considered as the representative of the brain in the Vertebrata, because it usually furnishes nerves to the organs of the senses. This brain is united by two connecting filaments to the abdominal nervous system, which is placed *below* the digestive tube, and consists essentially of a chain of nervous centres or ganglia united by other connecting filaments.

more especially distinguished by the infinite variability of characters which in all other cases exhibit the greatest constancy. In the Annelids the organs of motion and of circulation vary in the most marked degree in the different species. The respiratory system is sometimes developed in an almost exaggerated manner, whilst in other cases it is found to have completely disappeared, and that even in animals which are apparently very nearly allied to one another. The nervous system itself, that system which Cuvier characterised as the *entire animal*, presents no exception to this common law, for, in a special memoir on this important question, I have been able to demonstrate that this apparatus exhibits the most singular variations. Thus I found in other Tubicolous Annelids, and even in the Errantia, these abdominal nervous chains cleft into two halves, which were widely separated from each other; while on the other hand, I found in other species that this same chain formed along the median line merely a narrow and uniformly equal band, in the thickness of which the ganglia seemed as it were embedded; and between these two extremes I moreover discovered a great number of intermediate forms.

Thus those premature generalisations which have more especially originated from the exclusive study of animals belonging to a fixed type, vanish one by one before an examination which is daily becoming more and more severe; and thus we learn day by day more thoroughly to appreciate the scientific importance of the study of the *lower animals*. In this respect, botanists are in the same condition as zoologists. In

order to solve the most difficult problems of their own science, they no longer turn to the oak or the palm-tree for their information, but rather to the Algæ and the lower plants.

In no other animals does creation exhibit itself so completely in the light of a veritable Proteus as in the Annelids, which are at every moment assuming new forms, and surprising the observer by the manifestation of the most unexpected modifications. The Polyophthalmians exhibit one of the most curious examples of these metamorphoses; but here a few historical details become necessary, in order to show the great interest which attaches itself to the study of a small worm which is only a fraction of an inch in length.

The splendid discoveries of Ehrenberg revived in 1830 a discussion of originally a much more ancient date. Among naturalists, some, adopting the views of the illustrious Berlin microscopist, maintain that even the smallest animals, those, for instance, which in our scientific classifications are placed in the very lowest position of the zoological scale, present an organisation which is fully as complicated as those of the higher animals. Others, on the contrary, following the steps of the celebrated founder of the *Natur-Philosophie*, maintain with Oken that the organisation is simplified in a progressive manner the lower we descend in this scale; so that entire groups, composed to a certain extent of rudimentary animals, are almost entirely devoid of organisation. The latter class of observers agreed with Reaumur in regarding the Medusæ, for example, as nothing more than *masses*

of living jelly, whilst the Planarias and the greater number of Intestinal Worms in their estimation consist of little else than *Parenchyma*. In their eyes, this simplification of the organisms was carried to such an extent that whole classes of animals were regarded as altogether devoid of a nervous system.

In France and Germany, these opposite doctrines were attacked and supported with much heat and asperity. The discussion was commenced without a clear understanding on either side as to what is to be understood by the expression *inferior animals!* and consequently it soon led to much exaggeration and error. Various works published during the last few years present the subject in its true aspect. Many points of detail undoubtedly still need elucidation, but it may be stated generally, that wherever we study even the lowest animals with care and exactness, the results of our investigations will show us that even in their case a very decided *organic complication* is apparent. The advocates of *organic simplicity* are daily losing ground, and at present they are unable to defend themselves except by having recourse to the negative results yielded by the Infusoria; that is to say, by beings whose excessive minuteness places the majority beyond our means of investigation.

Amongst the most warmly discussed points of fact or theory in this quarrel, we must place that of the existence of distinct organs of the senses, and more especially of eyes, in a great number of animals which belong to the three divisions of the Mollusca, Articulata, and Radiata.

Ehrenberg had regarded as organs of vision certain coloured points which are met with in the margin of the umbrella in the Medusæ, at the extremities of the rays in the Star-fishes, in the head among the Annelids, Planarias, Rotifers, &c., and at one of the extremities of the body in certain of the Infusoria. The accuracy of most of these statements was denied in the most positive manner, although often very unjustly. In proportion as these creatures have been more profoundly studied, it has been found, in the case of those animals whose size rendered them accessible to our methods of examination, that the greater number actually possessed true organs of vision. The most abundant evidence on this point has been contributed by naturalists of every European nation.

The Annelids more especially furnished me with a very striking example of this fact. One of the species, which lives in the Sicilian seas, possesses eyes which are almost as complete as those of a fish. I have succeeded in enucleating the crystalline lens, and in examining it separately; and I found that when it was placed upon a piece of thin glass which received the parallel rays transmitted to it by a plane mirror, it formed perfectly achromatic images. These images repeated and magnified by the microscope enabled me to distinguish with perfect clearness the very smallest details of the neighbouring coast, and by means of the crystalline lens of an Annelid my microscope was thus converted into a telescope.

The opposition which Ehrenberg met with was even more strongly marked when he announced that

he had discovered an Annelid, the Amphicora, which carried at the *end of its tail* two eyes, which were perfectly similar to those which were upon its head. How, it was asked, were we to admit such a transposition of the senses? how was it to be supposed that eyes could exist at so great a distance from the brain, and without having any probable connection with it? The question was thus made a general one, and consequently acquired a very high degree of physiological importance. It was no longer sufficient to ascertain whether eyes did or did not exist, but it was now further necessary to decide if any one portion of the nervous system, excepting the brain, could become the seat of sensorial perception.

If by the word *eye* we must understand an organ which is always the same, and everywhere similar to that which we find in Man or Birds, Annelids, Nemertes, Planarias, and Medusas are certainly blind animals, but, like every organic apparatus, the visual organ may be simplified and *degraded*, without, on that account, changing its nature. Even in this state of degradation it maintains its fundamental parts, and these parts are generally easy of recognition.

Although destined to fulfil an entirely *physiological* function, the eye is a true *physical* apparatus. It always consists of a *camera obscura*, in which a *converging lens* concentrates the light, and throws the image of external objects on a *screen* which is placed in its focus. But here the lens instead of being formed of inert matter is organised, and is known as the *crystalline lens*. The screen is also living, and bears the name of the *retina*, and it is through the

latter that the impression received from images is transmitted to the brain. However varied may be the degree of complication in an eye, its fundamental parts always consist of a crystalline lens and a retina. We are therefore on the other hand bound to consider as a true eye every organ which possesses these characteristic elements; for it could not fulfil any other functions but those of which we have spoken. To decide this general question advanced by Ehrenberg, and to ascertain whether in fact the visual organ can be thus transposed, or, in other words, whether it can exist elsewhere than in the head, we must necessarily find in the Amphicora, or in every other animal presenting analogous facts, the crystalline lens and retina of the eyes.*

In this respect my investigations continued for a long time to be unsuccessful. On the coasts of the Channel and of Sicily, I had found many Annelids allied to the Amphicora, and bearing on the posterior extremity of their bodies the coloured points in question. In some of the species that I had discovered, these coloured points were moreover strangely multiplied. There were several of them on the head, four at the extremity of the tail, and two on each ring of the body. This multiplication seemed to me to present in itself a very serious objection to the views of Ehrenberg. How was it possible to believe in such a profusion of visual organs? Yet the study of the living animals seemed to confirm this determination. I saw the tail fulfilling all the functions of

* The term crystalline lens is here used to express generally the whole refractive apparatus of the eye.

the head, and this with evident proofs of spontaneity and intelligence. In moving, the tail went first, explored the objects without touching them, and turned aside from obstacles that lay in its path; in a word, it acted as if it were the seat of distinct vision, and as if it were directed by a clear will. Nevertheless, notwithstanding the many hours which I devoted to these observations, I was unable to discover either a crystalline lens or a retina; and hence my conviction in reference to so delicate a question as this could not be conclusive.

At length, among the Corallines, those small Algæ which cover the rocks with their closely compressed tufts as the moss mantles over the stone, I discovered the Polyophthalmians (*Polyophthalmia*). Here there was no longer any room for doubt; the fable of Argus was realised before me on the most incontestible evidence. Imagine to yourself a nearly cylindrical little worm, of a golden yellow, about an inch in length, and armed with two rows of setæ, whose length increased from before backwards, and you may perhaps form some idea of the aspect presented by the Polyophthalmians in a state of repose. In the sand where it passes its life this animal moves with incredible rapidity, by means of the general contractions of its body and the setæ which serve it in place of feet, but as soon as it wishes to swim freely in the water, or merely to place itself in such a manner that the little animals with which it is nourished may be within reach of its mouth, two large ciliated structures, which are placed on

the sides of its head, are protruded and act like the two paddle-wheels of a steam-boat.

With the view of directing its course, the Poly-ophthalmian is provided on its head with three eyes, each of which is furnished with two or three voluminous crystalline lenses, very easy of recognition. Besides this, on each side of the rings of its body there appears on either side a red point, very similar to those of certain of the Amphicoræ. On dissection, we find that each of these points receives a large nerve issuing from the ganglion or ventral nervous centre corresponding to it. By the help of the microscope, we can see that this nerve penetrates into a mass of pigment, which encloses a spherical crystalline lens, and we now see that the textures lying before it have undergone a modification by which they are rendered more completely and equably transparent. In a word, we can no longer doubt that these red points, which are placed on the sides and along the whole length of the body, are true eyes, receiving their optic nerves from the abdominal nervous centres, and having no direct connection with the brain.

This result, however strange it may appear, is not the only one of the kind by which modern science has been enriched. The Mollusca furnish us with several facts of the same nature. Most of our readers are no doubt acquainted with the Pecten, which is commonly known as *St. James's* or the *pilgrim's shell.* The animal which inhabits this shell somewhat resembles the oyster, and possesses like the latter a mantle or thin covering of living tissue, which lines

the interior of its habitation. The Pecten, which is as restless as the oyster is sedentary, possesses organs of vision, and these organs are not placed upon the head, nor are they connected with a brain, but they occupy the margins of the mantle, and derive their optic nerves from the great ventral ganglion.

These very curious facts were published more than ten years ago in Germany.* I have been able to verify these observations at different times, and I have detected in these eyes in the mantle of a Mollusc almost all the parts which are present in the eyes of a Mammal, including even the eyelashes and eyebrows, which are here represented by fleshy cirrhi which surround and protect the delicate organ of vision. Three German naturalists, Grube†, Krohn, and Will, have extended these researches to other genera of Acephalous Molluscs, and they have detected a similar organisation in the Spondyli, Tellinæ, Pinnæ, Arcæ, Pectunculi, &c. In the presence of such precise and abundant evidence, our observations on the Polyophthalmians lose their apparent improbability. Indeed, the multiplication of eyes, their lateral position, and their relations with other nervous centres than the brain, are perhaps less singular in this little Annelid than in the Molluscs of which we have just spoken.

Indeed, as in the case of all animals belonging to

* The existence of these eyes appears to have been long known; but no detailed anatomical description of them was published until 1840.

† Grube, a professor at Dorpat, has devoted himself, with much success, to the history of the Annelids. He has published several zoological and anatomical memoirs on this subject.

the group of Annelids, the body of the Polyophthalmians is formed of a series of rings, joined together piece by piece, and presenting very great resemblance to one another. In the largest Annelids one may easily convince oneself of the slightness of the connection which exists between these rings. A certain number of them may even be killed or affected by gangrene, while the others, and more especially those which precede them, do not appear to suffer in any way. Each of them is to a certain extent a complete animal, having as it were its own life, while the entire body may be considered as a kind of colony, of which the head would be the chief, or rather the guide. This is the portion which usually possesses organs of the senses. On cutting it off, the body can undoubtedly no longer see, and it also becomes deprived of organs of touch, but as far as we can judge, it still experiences tolerably precise sensations, and manifests a will. Thus, for instance, severed portions of the Eunice evidently avoid the light and bury themselves in the mud by a succession of movements which exhibit no appearance of confusion.

What, then, can be wanting to these severed segments, to these isolated rings, to render them so many complete animals? Assuredly, they can only need organs of sensation generally, and more particularly organs of sight. Now we find that both the Amphicoræ and the Polyophthalmia are Annelids, in which each ring, by receiving these organs, and consequently by presenting so much the greater resemblance to the head, most completely realises one

of the most characteristic tendencies of the group. Considered in this respect, they are only Annelids which possess a greater degree of perfection than the others.

This remarkable independence of the different parts of the body of the same animal, and the strange diffusion of the faculties of perception and of a reasoning will through all parts of the nervous system, are not exclusively exhibited by the Annelids. The same thing is to be met with in insects, animals whose organic complication exceeds in many respects even that of man himself.*

The experiments of Dugès leave no doubt on this point. If you imitate this skilful and lamented naturalist, and if you successively remove from a Praying Mantis the head and the posterior part of the body, the prothorax which remains will live for more than an hour, although it now only contains a single ganglion. If you attempt to seize it, you will find that the aggressive feet of the animal will be directed towards your fingers, into which it will bury the powerful hooks with which they are armed. The abdominal ganglion, which alone animates the ring, has therefore *felt* the fingers which pressed the segment; it has *recognised* the point that was pressed by a foreign body; it *wishes* to free itself from this constraint, and hence it *directs* towards the point that has been attacked its natural arms, and *co-ordi-*

* Lyonnet, in his admirable *Anatomie de la Chenille du Saule*, and M. Strauss-Durckheim, in his *Anatomie du Hanneton*, have placed this general result beyond all doubt.

nates their movements. This ganglion, although completely isolated, comports itself therefore like a perfect brain.

Hence we may see how the study of the lower animals leads us to ideas which are apparently very different from those that are to be deduced from the exclusive study of the higher animals. Science, however, does not on that account change, but it simply becomes more complete, and, by revealing to us new horizons, it daily enlarges and satisfies more and more the noblest aspirations and requirements of human intelligence.

CHAP. VIII.

THE BAY OF BISCAY.

SAINT SEBASTIAN.

The road leading from Saint-Jean-de-Luz to Saint Sebastian; the Bidassoa; the Isle of Pheasants.—Saint Sebastian.—The Basques: their claims as a race; their probable origin; their *fueros*; their ethnological characters.— The Teredo; its mode of reproduction; means of preserving wood from its attacks. — Embryological studies; nature of germs; theories of evolution, of *accolement* and of epigenesis; distinct life of germs. — Development of the Hermella and the Teredo.—Metamorphoses.—General idea of life.

TOWARDS the close of autumn, I left the French Basque territory on my way to Spain. On leaving Saint-Jean-de-Luz the road winds among rich and smiling hills, passing here and there some village, similar to Guettary, or some detached house whose white walls and red shutters gleamed from the midst of the verdure with which they are usually surrounded. After gradually ascending, the traveller finds himself suddenly on the top of a long and rapid slope, from whence he sees a lovely valley, which contracts towards the left and is lost on the horizon amid the passes of the Pyrenees, whilst to the right it widens considerably and then gradually slopes towards the sea between Point Saint Anne and Cape Figuier. The Bidassoa and the Isle of Pheasants are at his feet, recalling the memory of names which are alike

great in geography and in history. Yet the stream is so shallow and contains so little water, that at low tides it almost disappears in the sand before it reaches the ocean, whilst the island has been so buried under the accumulations of each season that it is now little more than a sand bank, on which a few half uprooted willows struggle for existence. But this brook is the boundary of France, and this islet was the meeting place of Louis XIV. and Philip IV. The greatness of these recollections, and the inexplicable sentiment which we always experience at the moment of crossing our native frontier, compensate for the actual smallness of the objects, and you descend the hill, and, passing the wooden bridge at Behobie, and almost before you are aware of it, you find that you are in Spain, by being summoned to show your passport at the gate of the Custom House of Irun. Indeed, you will scarcely have found time to cast a hasty glance at Fontarabia, that Moresco-Spanish town, which from the height of its isolated rock can direct the fire of its bastions over the entire plain, while it raises towards the sky its lofty towers and belfries as if the better to keep watch over the sandy bay which encircles its base.

Owing to the direct road which now connects Irun and Saint Sebastian, the diligence conveys you in two hours to the capital of Guipuzcoa. If you enter the *Parador Real*, the best hotel in the town, you must request, if you are a naturalist, to have a room in the back of the house, and you will find yourself in an apartment as large as a ball-room, and lighted by a high double window, from which you have a view of the

rock of Santa Clara and the entrance of the roadstead. If you arrange your microscope, pencils, and brushes, on the solid table which the landlady will speedily bring at your request, and place your bottles and phials on the broad sideboard which occupies one entire side of the apartment, you may, if you have the day before you and are in good walking condition, set forth on a tour of exploration, and traversing the town from south to north ascend the zig-zag paths of Mount Orgullo. You will soon find that you have made the circuit of the entire mountain, and passing on the one side the batteries which protect the entrance of the harbour, you will admire the wild beauty of the English cemetery, where rise in the midst of broken masses of rock the graves of several officers who were killed in the Carlist wars, and having finally reached the dungeons of the Castillo, your eye will embrace at one glance the whole of Saint Sebastian and its environs.

An amphitheatre of hills, which soon become sufficiently elevated to merit the title of mountains, curves in a semicircle before you, stretching on the left hand into the sea, where it terminates in the cliffs of Mount Ulia, while to the right it extends to the lighthouse and the rocks of Mount Igueldo. A narrow and low tongue of land, which is detached from the continent, separates into two very nearly equal parts the basin or harbour, which is about two miles broad and extends three quarters of a mile inland, widening a little before it reaches Mount Orgullo. This is the point of land on which Saint Sebastian is built. To the east, at the foot of the ramparts of the town, you

see the mouth of the Urumea, whose winding course can be traced till it disappears at a projecting point of the valley, where it turns in the direction of Astigaraga. The actual roadstead is on the other side, and here it presents only a narrow channel towards the sea, being protected by the advanced rocks of Mount Orgullo, the island of Santa Clara, and the chain of rocks which connect the latter with Mount Igueldo. A magnificent beach of fine sand borders this channel in a semicircle which is only interrupted by the rocky point on which stood before the late wars the chapel of La Antigua. This beach, which merges into the sea by a scarcely perceptible slope, is every summer the *rendezvous* of numerous bathers, who come hither from all parts of Spain either in search of pleasure or of health. The harbour itself is situated immediately at the foot of Mount Orgullo, completely sheltered on all sides, and covered even in the direction of the roadstead by four jetties which mutually protect one another.

It might be supposed that this roadstead and harbour, which art and nature seem to have combined to place beyond the reach of any external influences, would present unusual conditions of safety; such, however, is far from being the case, for there are occasional storms, when the winds and waves exert a power which defies all attempts at description. I have often witnessed at Saint Sebastian a violent outburst of storm and wind which would elsewhere be regarded as a frightful hurricane, but which the people of the district only characterised as roughish weather. I am not, however, about to give a description of

these storms, for I know no pen or pencil that could afford any just idea of these convulsions of the atmosphere, or of the excessive violence of the wind which continued to blow for forty-eight hours in the same manner as it blew for a few moments in Paris on the day of the waterspout at Montville. No one could adequately depict those enormous waves that were sometimes swept by the hurricane into foam which was blown over the beach like flakes of snow, and at another time rose in vast masses up the inclined slopes of Santa Clara like reversed cataracts, crowning even the summit of the rock, which is very nearly as high as the platform of Notre-Dame, and darkening the atmosphere with humid dust which rose to the very top of the lighthouse, whose elevation certainly equals that of Montmartre. Those gigantic billows which passed through the narrow channel of the roadstead expanded within the bay into a large fan-like shape, by which the violence of the waves was proportionally diminished, and yet within the harbour the ships were striking against one another, and one unfortunate brig, after having broken away from its moorings and vainly sought shelter behind the Castillo, was at last obliged to yield to the frightful pressure of the water, and finally ran aground and was wrecked near the base of the harbour.

In the midst of this confusion of the elements, white-plumed burgomasters and red-coloured ospreys were sporting tranquilly before my windows, blending their cries with the crash of the tempest, describing in their aërial course a thousand capricious curves

and lines, and plunging from time to time between two billows, from which they soon re-appeared holding a fish in their beak. Their flight, which is as rapid as that of the arrow when they suffer themselves to be impelled by the wind, is slackened when they face the hurricane, but in either case they rise with the same ease and facility as in the calmest days. There was something remarkable and most singular in the sight of these birds which, with their wings extended and apparently immoveable, could progress in a steady and uniform manner in the face of squalls of wind which would have thrown down the strongest man. MM. Quoy and Gaimard long since drew attention to this singular phenomenon in large aquatic birds of the antarctic regions. These two observers, after having thousands of times watched the albatross and the frigate-bird on the wing, have hesitated to offer any explanation of the manner in which their flight is accomplished. Others, with less diffidence, and after merely examining the same species through the glass cases of our museums, have decided that this mode of locomotion is the simplest thing in the world. They discourse gravely of *acquired velocity*, of an *invisible tremulous movement* of the wings, &c.; but for our own part, after having watched the same phenomena, we are bound to admit that we agree entirely with MM. Quoy and Gaimard, whose cautious reserve we shall imitate.

Fortifications *à la Vauban*, with a raised rampart whose fosses are filled during high tide, occupy the entire width of the isthmus which joins Saint Sebastian to the continent and protect it on the land side.

Nestling at the foot of Mount Orgullo, as if it were seeking shelter from the north wind, and circumscribed by its walls which the sea beats on either side, the capital of Guipuuzcoa forms an irregular square whose surface is less than 120,000 square yards in superficies. But this narrow space has been turned to the best possible advantage. Two parochial churches, a convent, an arsenal and barracks, constitute the principal public edifices, which are almost all erected on the lowest declivities of Mount Orgullo. In the centre of the town the Hall of *Ayuntamiento* occupies the entire side of a square surrounded by arcades, something like the Palais-Royal on a small scale. The remainder of the ground is mainly occupied by lofty houses, forming streets which are almost all of them perfectly straight, and whose width appears to be strictly calculated in accordance with the necessities of the traffic. Here are no gardens and scarcely any courts attached to the houses, and in consequence of this economy of ground the space within the walls affords accommodation to a population of 9,000 souls.

Notwithstanding this accumulation of inhabitants, the town exhibits a degree of cleanliness which is very uncommon in our large cities. This fact is more especially explained by the manner in which the population is distributed. Saint Sebastian has none of those streets and alleys filled with mean and low houses, which disfigure even our finest cities, and which afford shelter to the poorer classes. Almost in every part of the town the houses are equally good and very similar to one another, and they are

all filled by tenants of every class. The mercantile or professional people occupy the ground floors and the first floors, whilst the boatmen, fishermen, and artisans have their abode in the attics and garrets. A great advantage results from this admixture of society. The rich become acquainted with, and can relieve the miseries of their poorer neighbours with whom they are thus brought in contact, whilst the poor in their turn, being constantly thrown under the notice of the wealthier classes, are forced, as it were, to avoid that kind of indifference which amongst their order so often degenerates into recklessness and slovenliness.

Saint Sebastian is almost entirely a new town, and with the exception of the churches and a few houses placed near them, all the other buildings are recent. In 1813, the English and Portuguese, those allies which Spain designated by the title of her liberators, when she rose against Napoleon, reduced to ashes the ancient Donestia.* Saint Sebastian has now, however, risen entirely from her ruins. At the period of my sojourn, a few crumbling walls and some heaps of rubbish lying between my windows and the harbour were the only evidences of the demolition that had resulted from the horrors of war. The ancient capital of Guipuzcoa has now recovered its former rank. Industry and commerce have brought back prosperity within her walls, and, as in past times, Saint Sebastian is one of the principal centres of the Basque population. It

* The Basque name of Saint Sebastian.

may easily be understood with what interest I studied this remarkable race, which has no affinity with any other European nation, and whose origin is one of the most difficult problems of Ethnology. He would ill deserve the title of naturalist who, being exclusively occupied with the study of animals, should neglect that of the human race, or should hesitate to attach the highest importance to everything that might throw light on the history of its innumerable varieties.

The Basques, called by different authors Cantabrians, Euskarians, and Euskaldunes, give themselves the name of *Euskaldunac.** They speak a language which has no analogy with other European dialects, and they designate it as the *Eskuara*, or the *Euskara* tongue.† Distinguished from all neighbouring populations by their physical and moral character, their customs and institutions, they differ from them still more by their religious belief and traditions.

The ancient Euskarian myths speak, according to some authors, of the destruction of a former world, from which only a few men escaped, "as few in number as the olives which remain upon the tree after the fruit has been gathered in, and as rare as the grapes

* This word is formed by contraction from *Eskua-alde-dunac*, which signifies a people of skilful hands. (*Histoire des Cantabres, ou des premiers Colons de toute l'Europe, avec celle des Basques, leurs descendants directs*, by the Abbé d'Hiarce of Bidassouet. Paris, 1825.)

† The language of the hand, the science of gesture.

which hang upon the vines after the vintage is over.* " Of this number was Aïtor, the ancestor of the Euskaldunac. Having retired with his wife into an inaccessible grotto, Aïtor lived for a whole year in the midst of fire and water, which were disputing for supremacy everywhere around him. Overwhelmed with terror, he forgot all the knowledge that had been transmitted to him by his ancestors concerning past events, and having even forgotten his own language, he invented a new tongue. The sons of Aïtor having descended into the plains, spread rapidly, and soon formed powerful nations, which always faithfully preserved the language and religion of *the father that had descended from high places, their ancestor of the mountains.*† Polytheism in its coarse and material aspect never prevailed among the Euskarians. These people adored a supreme being, the Creator and Preserver of the world, their Jao-on-Goïca.‡ They began and ended the day by addressing him in prayer, and they offered him in sacrifice the fruits of the earth by the hands of the ancient men of their tribe; but they did not raise any temple to him. Their religious ceremonies, which were always very simple, took place at certain epochs determined by celestial phenomena, and were all performed under the same oak beneath which their old men, who had be-

* *Philosophie des Religions comparées*, by Augustin Chaho. Paris, 1848.

† *Artagoia, Arbassoia*, names given to Aïtor. (*Philosophie des Religions comparées.*)

‡ Or by contraction *Jainkoa*, the lord on high. (Augustin Chaho, the Abbé d'Hiarce.)

come chiefs by the privilege of age, administered justice and regulated the affairs of the nation. The Basques believed in the immortality of the soul, and in rewards and punishments after this life. In their eyes natural death was nothing more than a long sleep, and the grave, in their language, is called *the bed of profound repose.**

A people whose religion had always possessed this spiritual character would of necessity be easily led to embrace Christianity. The Basques themselves boast of having been the first Christian nation. Their national traditions readily accommodated themselves to the new faith. The Euskarians have thus, as it were, arrogated to their own use the claims advanced by the other Spanish tribes in reference to the antiquity of their race. The Spaniards generally claim as their special ancestors the immediate descendants of Noah, without, however, being entirely agreed as to the precise period when these first colonists arrived in Spain. Mariana, Joseph Moret, Gabriel de Henao, Florian d'Ocampo, and Ferreras, have all adopted the version which Alphonso Tostat

* Augustin Chaho. We leave to this writer, to the Abbé d'Hiarce, and to the Basque authors who have preceded them in the same track, the entire responsibility of these assertions regarding the ancient spiritualism of the Euskarians. M. d'Avezac, whose opinion ought here to have great weight, regards all these pretended traditions as so many modern inventions, and even as having been entirely forged by those who have quoted them as evidences of popular belief. However it seemed to us that it might be interesting to our readers to know what has been recently advanced by Spanish archæologists, or by the eccentricities of an exaggerated patriotism, in reference to the origin of the Basques.

had derived from the *Leyenda Pendolada*, written in 1073, by Herman Llanes.* According to these writers, Tubal, the son of Japhet, came, 131 years after the Deluge, to settle down on the western extremity of Europe, and this primitive race subsequently spread its colonies over the whole of Europe, the northern coasts of Africa, and even a portion of Asia. Other writers, such as Bochart, Ponce de Leon, Joseph Pellicer, Xavier de Gama, Manuel de la Huerta, &c., admit that the sons of Japhet, proceeding from east to west, began to people the central portions of Europe, and did not arrive in Spain until 535 years after the Deluge, under the leadership of Tarsis, the cousin german of Tubal. These two versions, which have been attacked and maintained with equal asperity, are universally current among all clases, both parties invoking Holy Writ in support of their favourite view. The ecclesiastical tribunals, being called upon to pronounce between the two, adopted an expedient, which was certainly alike ingenious and prudent. They admitted that both opinions were equally probable, but that the truth must belong exclusively to the one or the other. This decision became an article of faith, and even as lately as the close of the last century it would not have been prudent for a Spanish author to recognise any other chief of his race than Tubal or Tarsis, if he would avoid being

* *De l'Ibérie, ou Essai critique sur l'origine des premières populations de l'Espagne*, by L. F. Graslin, formerly French consul at Santander.

called to account by the inquisition, as if he had been guilty of a heresy.

The Basques, who consider themselves as the sole representatives of the ancient Iberian people, have not failed to avail themselves of the results of this controversy. A sort of Christian mythology has replaced among them the vague traditions of former times. Aïtor has become Noah; he is the father of the Euskaldunac; from whence it results that the latter are the progenitors of all other nations. According to their legends, Spain more particularly was peopled directly by the companions of Tubal or of Tarsis *, whose descendants spread themselves over the whole of Europe, and possibly other parts of the world. Is the Euskara language, in truth, the same which, according to the common belief, was spoken by Adam and Eve in their terrestrial paradise? This is very possible, for Noah may have received it traditionally, and in that case he would have transmitted it to his descendants. It is true that the latter, wishing to defy the Almighty by erecting the Tower of Babel, were struck with confusion, seventy-two tongues having suddenly replaced the single language they had received from their fathers. But the Scriptures do not inform us of the year in which the pride of men brought upon them this punishment. It is therefore not impossible, that the colony which was

* We find that all modern Basque authors maintain these two opinions, which were first advanced by Spanish writers. Thus, for instance, the Abbé d'Hiarce regards Tarsis as the founder of the first Iberian colony, whilst Larramendi, who in this respect is followed by M. Chaho, refers its origin as far back as Tubal.

destined to people Europe and Spain, might have set forth on their wanderings before this epoch.* It might thus have brought with it the language which was coeval with the earliest ages of the world; and if this were the case popular traditions may be a mere expression of the truth.

At all events, say these ultra-patriotic Basques, the Euskara language is infinitely superior to all known tongues for its priority, universality, inexhaustibility, naturalism, inflexions, niceties, terminations, allusions, and verbal mechanism. This language in itself contains radicals enough to suffice for the formation of the seventy-two languages which originated at the foot of the Tower of Babel.† No language therefore approximates more closely to that which was revealed to Adam by the Almighty.‡ Inspired by God, the Euskara language is as natural to the human species as cooing to the dove, barking to the dog, or bellowing to the bull. Every one, as he begins to stammer forth the first sounds, speaks Basque. *Papa, titi, Mama, caca,* those infantile sounds which are met with amongst almost all people, and whose signification is sufficiently obvious, are,

* The Abbé d'Hiarce.

† According to Don Publo de Astorloa, the Basque language possesses more than four hundred thousand words of one, two, or three syllables, exclusive of those which result from the combination of different radicals. (*Apologia de la Lengua bascongada,* Madrid 1803.) We ought to add that some Basque words consist of sixteen syllables.

‡ Such is the conclusion of the grammatical theorems which the Abbé d'Hiarce believes that he has demonstrated. Don Pablo de Astorloa had advanced the same pretensions in the work which we have already quoted.

according to the Abbé d'Hiarce, pure Euskarian words. This language having its roots in the very nature of things, its study suffices to reveal to us the origin of all the arts and sciences. Its names of numbers include in thirteen words all the fundamental principles of natural philosophy, and the numerical mysteries of Plato, or of Pythagoras, could never have been established excepting on the principles of Basque numeration. The Euskarian alphabet is in itself a revelation. Its name is *Yesus*. The five vowels taken together in the usual order, present a complete idea of the primordial world and of the creation.* Three amongst them, namely, *i*, *a*, *o*, when united into a single word, include within themselves the adamic verb, expressing at the same time both *life*, *incarnation* and *spirit*, the beginning, end, and middle. *Iao* is the true name of God, a sublime name revealed in the early ages to the patriarchs of the south, which although corrupted by the Hebrew Levites and the Celto-Roman pontiffs, has been preserved through all time, and is still venerated by the Euskarians.†

Setting aside the exaggeration and absurdity of the linguistic pretensions of the Basques, it is impossible to deny that their language is truly remarkable, and that it presents many special characters. Wilhelm von Humboldt‡ thinks that

* The Abbé d'Hiarce, *Histoire des Cantabres*. Don Juan Bautista de Erro y Aspiros, *Alfabeto primitivo de la lengua primitiva de España*, Madrid, 1806, and *El mundo primitivo*, Madrid, 1815.

† *Philosophie des religions comparées*, by Augustin Chaho.

‡ [A sketch of the life and labours of Wilhelm von Humboldt and his brother Alexander is given in the Appendix, Note III.]

it cannot be referred to any language of the Indo-Germanic family. In the first place, it is entirely distinct from all the Celtic dialects, and indeed the only languages to which it in any way approximates by its grammatical construction, are, according to Humboldt, a few of the American dialects. On the other hand, the Abbé d'Hiarce has detected in a vocabulary that was brought by Péron from Van. Diemen's Land, several words which he asserts to be strictly Basque. It is somewhat strange that we should have to go so far for the only analogies connecting this dialect with other known languages.

It is, moreover, almost impossible for foreigners ever to learn to speak the Basque language. Some of the grammatical theorems of the Abbé d'Hiarce may serve to give an idea of its difficulties. In Basque, nouns, pronouns, and adjectives may be changed into verbs, whilst verbs become metamorphosed into nouns and adjectives. Prepositions, adverbs, conjunctions, interjections, and even the letters of the alphabet are declined like Latin nouns or adjectives, and conjugated like verbs. Every noun has six nominatives and twelve different cases, whilst adjectives have as many as twenty cases. The noun often changes in accordance with the condition of the individual or thing which it serves to designate. Every French verb is represented by twenty-six verbs, each of which expresses a special modification either of the person or thing on which the action of the verb is exerted. There are moreover four different conjugations, which are used according as the speaker addresses a child or woman, an equal or a

superior. These illustrations will we think suffice to refute the assertion that the Euskarian tongue could ever very easily become a universal language. And indeed it has hitherto been limited solely to the Basques, who very easily learn both Spanish and French, although their own language is never learned by their neighbours of Spain or France.

A history whose origin dates as far back as 535 years after the Deluge must necessarily present several remarkable peculiarities. Thus, we find in the annals of the Basques. side by side with the patriarchs, persons of very different origin. After the death of Tarsis, the Euskarians of Spain elected Geryon as their king, who, to immortalise the remembrance of his reign, built two powerful cities, namely, Girone to the north, and Cadiz to the south; but this sovereign, forgetting that a king should be merely the father of his people, attempted to tyrannise over his subjects. They, however, revolted against him, and Osiris king of Egypt, having assisted them by force of arms, Geryon was defeated and killed on the plains of Tarifa, not far from the Straits of Gibraltar. His three sons succeeded him, but being similar in character to their father, they caused Osiris to be assassinated by Typhon. Orus, the Libyan Hercules, now hastened from the depths of Scythia, and having challenged them to single combat, killed them and erected as monuments of his victory the two celebrated pillars which bear his name. Two companions at arms of Hercules, Hispalis and Atlantis, successively occupied the throne of Spain. Siculus, the son of the latter, reigned

over Spain and Italy, and having conquered Sicily he peopled it with Euskarians. After Siculus, the race of Tarsis recovered the supreme power, which they maintained until the time when the great legislator, Abides, having voluntarily renounced the throne, organised Iberia into a vast federal republic, 1014 years before the foundation of Rome. From Abides, or his contemporaries, have descended all the *dukes* or chiefs of the federal republics, all the heroes in which Spain glories, and more particularly Pelages and his companions. Thus, in accordance with this genealogy, the Spanish nation is still governed by a Euskarian or Basque family, and Queen Isabella is descended in a direct line from Tarsis and from Noah!

We thus see that even in the present day the Basque historians write under the influence of preconceived ideas which totally exclude the possibility of discussion. This is the more to be regretted, because if they could lay aside the prejudices of a false national pride, their researches would undoubtedly have led to singular discoveries. From the midst even of their exaggerations we may deduce one important result. Thus, for instance, we find in the Euskarian language the etymology of a great number of the names of rivers and mountains, and of provinces where the Basque race no longer exists.* This fact,

* Larramendi, Astorloa, de Erro and the Abbé d'Hiarce, may be named among the authors who have given way to exaggeration in their etymological systems. Thus, for instance, they have attempted to prove that the names of Sweden, Norway, and Denmark, together with those of Helicon, Cyprus, Delos, &c., were primitive Basque

which was proved by the illustrious Wilhelm von Humboldt, who visited Biscay expressly for the purpose of verifying the exactness of these etymologies, confirms some of the Euskarian traditions, for since the time of Leibnitz *, local appellations, which it is

names, and they have made similar statements with regard to Lutetia, Versailles, Orleans, Arras, &c. The natural conclusion to be derived from all these strained etymologies is, that the Basques are the primitive race; and that the whole of Europe has been peopled by them.

* Leibnitz, one of the most distinguished men of modern times, was born at Leipsic in 1646, and died in 1716. From his childhood he had manifested a decided taste for study. Having been enabled to make free use of an extensive library, he read everything that fell in his way. Fortunately the standard works of the ancients were among the first which engaged his attention, and they early led him to entertain a marked predilection for the genius of antiquity, which he maintained during the rest of his life.

After having attained to the most brilliant success in the study of civil law and jurisprudence, he obtained the title of doctor at the age of twenty, at the University of Altdorf, where he distinguished himself in so marked a manner, that the authorities offered him a chair in that university. Leibnitz, however, had other views, being anxious to enlarge his mind by travelling. He came to Paris in 1672, being already known to the learned world by the publication of various memoirs, and here he at once devoted himself to the study of mathematics, under the direction of Huygens. His success in this branch of knowledge was so great, that Fontenelle was able to say of him, with truth, that his name was connected with the most sublime problems that have been solved in modern times, while it is moreover intimately associated with all the great, difficult, and most important achievements of modern geometry.

Leibnitz familiarised himself with every department of physical and natural science. He wrote alternately on physics, chemistry, medicine, physiology, zoology, and botany, while in his work entitled *Protogea* he was the first to indicate the method which we now pursue in our geological studies.

His philosophical works were, however, those which gave Leibnitz

difficult to change, are justly considered as one of the most constant indications which may assist us in recovering traces of an extinct or transplanted race.

When we combine the data furnished by this study with some passages in the Greek and Roman historians, we are led to admit that the Basque race must have formerly been much more widely extended than at the present day. It is probable that it occupied a large portion of Italy, the eastern coasts of Gaul, and the whole of Spain; while it may also have partially colonised the islands of the Mediterranean, together with the Libyan provinces.* It is to the nations of this race that Prichard has given the name of Iberians. They appear early to have attained a certain degree of civilisation. They were acquainted with the art of writing, and their alphabet, which is undoubtedly derived from the Phœnician letters,

the highest reputation. Being deeply impressed with religious sentiments, he could not accommodate his mind either to sensualism or to pantheism, and while he always endeavoured to discover the practical bearing of even the highest theories, he rejected all approach to exaggerated idealism. His system, which has been termed a *Spiritualistic Realism*, is principally expounded in the work entitled *Monadologia*, which he wrote for Prince Eugene. In the application of his views to science, and more particularly to the natural sciences, we find the first traces of those ideas which Bonnet and his successors advanced in reference to the progressive series of organised beings.

* The Libyans are the ancestors of the modern Berbers, and form a branch of the great Semitic or Syro-Arab race. They occupy the northern coast of Africa, from Egypt to the Straits of Gibraltar, and all the western portion of the African continent, known to the Romans and Greeks. (Prichard's *Natural History of Man.*)

bore some resemblance to those of the ancient Italian nations.

Modern science has been less successful in its endeavours to connect the primitive Spaniards with one of those great families into which the different varieties of the human races are classed. Here everything is mere conjecture. Bory Saint-Vincent makes the first inhabitants of Spain come from the fabulous Atlantis of Plato.* M. Petit-Radel regards them as having issued from Latium and Etruria.† MM. Michelet ‡ and de Brotonne § see in them a Celtic race, while M. Graslin considers them to be a Celto-Scythian off-shoot.‖ Some of these authors, moreover, distinguish the early Iberians from the nations who speak Euskarian, and deny to the latter the importance which we have assigned to them in accordance with the views of some of our most distinguished ethnologists.¶ Two learned inquirers have endeavoured to connect the Euskarians with the Finnish nation **, whilst M. Dartey refers them to a Semitic

* *Essai géologique sur le genre humain.* Paris.

† *Mémoire sur les anciennes villes d'Espagne.* Paris, 1837.

‡ *Histoire de France.*

§ *Histoire de la filiation et de la migration des peuples.* Paris, 1837.

‖ *De l'Ibérie.*

¶ Abel de Rémusat, W. von Humboldt, A. Von Humboldt, Prichard, &c.

** Arndt, *Ueber die Verwandschaft der Europæischen Sprachen* 1810, and Rask *Ueber das Alter und die Echtheit der zend Sprache*, 1826. The Finnish race, having come from Asia, appears, according to the investigations of these inquirers, which have been confirmed by the osteographical researches of Retzius, to have occupied a great part of Europe before the Celtic invasion. It is

origin *, and this opinion appears to us to be the least improbable. Nevertheless, in the presence of such an absolute deficiency of precise information, we must admit that modern science is totally incompetent to solve this problem. While we regard the question as an open one, we concur with Prichard in regarding the Euskarians as a remnant of the ancient Iberian race, and consequently as an *aboriginal* people; that is to say, a nation who before our historic times occupied the districts in which we can still trace their former presence.

However this may be, the Iberians appear to have experienced the first loss of territory when the Ligurians, issuing from the borders of the river Ligys, which is supposed to be the Loire, took possession of the coasts included between the Rhone and Italy. At a later period, occurred the great invasion

from this race that the Magyars, amongst others, are descended; although their origin has long been a matter of dispute, and they themselves lay claim to a descent in a direct line from the first patriarchs, pretending that their original language was that of Adam. The traditions of the North represent that the first Finns were men of pallid complexion, with red hair, grey or bluish eyes, and a hideous expression of countenance. More or less deep traces of the same physical characteristics are still to be met with amongst the different tribes who have descended from this stock, and, as we shall presently see, these characters are extremely remote from the Basque type.

* *Recherches sur l'origine des peuples du Nord.* M. Vivien de Saint-Martin, who was good enough to communicate to me his notes on the works of Arndt, Rask, and Dartey, regards the opinion of the latter as historically untenable, but as probable, if we have reference merely to physical characteristics; and in this opinion we are ourselves disposed to concur.

of the Celtic tribes, whose descendants occupy almost the whole of Western Europe. The Celts, who were more powerful and more warlike than the Euskarians, almost everywhere exterminated them, leaving them no other asylum than the wild gorges of the Pyrenees.* Here, favoured by the nature of the ground, and having grown accustomed to war through necessity, the remnant of these nations formed several small confederate republics †, and struggled successfully against new invasions. Dating from historic times, we see all the conquerors repulsed from the natural strongholds which the courage of these mountaineers had rendered impregnable. Carthaginians, Romans, Goths, Franks, and Saracens, each in their turn attempted to subjugate the Basques. They often defeated them in pitched battles, they laid waste their valleys and their hills, and sometimes they even subdued them for a time to their yoke; but this subjection was only temporary or nominal, since the Basques never lost their nationality, whilst they have always obstinately retained their own manners and language.

The Euskarian populations were in truth rather the allies than the actual subjects of their pretended rulers. Ever ready to resume entire independence,

* According to M. Chaho, the giants, *Tartaro*, of which we read in popular legends, were merely Celts.

† The principal Euskarian tribes at the period of the Punic wars were the Cantabri and the Vascones. The latter subsequently gave their name to the whole of these provinces and the populations by which they were occupied. The present Basque tribes are the immediate descendants of the Vascon family.

they never hesitated boldly to seize the first opportunity of making sanguinary reprisals on their enemies, and the name of more than one spot is repeated in the Basque country with as much pride as that of Roncevalles. Nevertheless, in proportion as the states bordering upon the Euskarian confederation became more thoroughly developed, they absorbed the members of this small body which had never possessed a very homogeneous character.* But we everywhere find that the sovereigns granted their new feudatories exceptional privileges, and left them to govern themselves according to their own customs and usages.† Biscay and Guipuzcoa have

* The *Garazi* district which was peopled by Navarrese Basques, was re-united to the kingdom of Navarre in the year 906, by Sancho the Great. Alava voluntarily recognised the sovereignty of Alfonzo XI. King of Castile in 1330. Three years afterwards, this sovereign received on the same conditions the submission of Guipuzcoa and Biscay. The district of Labourt, or the French Basque country, remained for a long time in a wild uncultivated state. It was purchased in 1106 by the Guipuzcoan Basques, who, for the sum of 3,306 gold florins, obtained from Guettard, Viscount of Labourt and of Marennes, the right of cultivating the soil and of enjoying all the advantages attached to it. From this time Labourt shared in all the vicissitudes of this part of the country, and it was finally re-united to France by Charles VII. in 1451. *Histoire des Cantabres.*

† In France even the people of Labourt were exempted from all taxes, duties and imposts, in consideration of their paying annually a sum of 353 livres 10 sols, and maintaining a force of 1,000 militia for the purpose of guarding the frontiers. During the wars of Louis XIV. Labourt voluntarily imposed upon itself a subsidy of 22,600 livres, on the understanding that all its privileges should be preserved, and we find that they remained intact until the period of the Revolution.

preserved the language, manners, and institutions of their ancestors better than the other Basque provinces, and there is certainly something very singular in finding in the nineteenth century, and at a few paces only from France, a society which belongs essentially to the middle ages.*

The franchises of the Basque country, which have become celebrated under the name of *fueros*, regulated both their relations with the crown of Spain and the internal organisation of each province. In respect to the first point, there was but little difference between Biscay and Guipuzcoa. The king of Castille was the Lord Suzerain to whom they owed fealty and homage, and who raised a slight tax on certain houses and on the products of the mines. In case of any invasion of the country, the population was bound to rise *en masse*. On these conditions the provinces were exempt from all duties, taxes and imposts, their commerce was entirely free,

* It is well known what extraordinary precautions were taken by the Basques to maintain their privileges against all encroachments on the part of the crown. In Biscay, the *lord of Biscay*, the only title which was granted in the province to the king of Castille, was obliged to come in person to swear that he would maintain their *fueros*. He was bound to take four solemn oaths; the first at the gates of Bilbao before the General Assembly; the second at San-Meterio Celedon de Larravezua before the clergy in their ecclesiastical robes, and bearing the holy Sacrament; the third under the famous oak of Guernica, where the junta of Biscay assembled; and the fourth on the altar of Saint Euphemia, in the town of Bermeo. In case these formalities were not complied with within a year after the summons had been issued, the king of Castille lost all right to the revenues of the province, while the inhabitants were no longer bound to obey his orders.

and they only granted such a contingent of men and money as they judged suitable.

The province of Guipuzcoa, which was situated on the extreme frontier, contained a few strongholds, which were garrisoned by the troops of the king of Spain. They, moreover, received a general-commandant, who usually resided at Saint Sebastian *, but this officer could not act on his own authority, and his duty was chiefly limited to the joint consideration with the *Alcades* of all questions relating to the defence of the country. With respect to the province of Biscay, one of its most essential rights was to have neither troops nor royal fortresses in any part of its territory, the sovereign himself being obliged when he entered certain cities to leave behind him all his men at arms, and only to retain about his own person a small escort, whose number was carefully specified.

The internal government of Biscay and of Guipuzcoa differed in certain respects, but they had this in common, that independently of the general franchises, each town and each village, so to speak, had an entirely independent and special administration, and not unfrequently particular laws and special privileges. The province was in reality a federal state, composed of a great number of small republics governed by their *Alcades* and their *Ayuntamientos* †, all of

* This circumstance has led Saint Sebastian to be regarded as the capital of Guipuzcoa; but the expression is far from being exact, for in this province, the seat of the *Bilzar*, or general Annual Assembly, and of the Government Junta, changes every year.

† The province of Biscay includes 110 *infanzonados* or small

which had their representatives in the provincial estates called the *Bilzar*. To these were reserved the general administration, the fixing of imposts, and more especially the care of preserving intact the privilege of the *fueros*.

To take part in this national assembly, it was sufficient to be a Basque, or rather a landowner. The feudal hierarchy, such as we find in every other part of Europe, never existed amongst the Euskarians. It is true that all the Guipuzcoans were nobles by birth and enjoyed in Spain all the rights attached to that rank, and there were even certain towns of Biscay and Alava which conferred the same privileges on their inhabitants, but these were to a certain extent mere external distinctions which had no value whatever within the Basque territory. Even the highest titles conferred by the kings of Spain upon certain families did not establish any real distinction in their favour amongst their fellow-citizens. In Guipuzcoa, Biscay, and Alava, the constitution recognised neither nobles, marquesses, nor dukes; but, on the other hand, no one was regarded as *plebeian*. To take part in the deliberative assemblies, or in the public administration, it was only necessary to be *etcheco yauna*, that is to say, the master of a house, or a house-owner; and this quality being attached to the possession of the soil could be transmitted with it. A foreigner, however low his birth, might ac-

republics, having the right of sending delegates to the General Assembly. Guipuzcoa is less divided (*Aperçus sur la Biscaye, les Asturies et la Galice*, by Count Louis de Marillac. Paris. 1807.)

quire this title by the purchase of land; and he might even assume those of gentleman, nobleman, or *hidalgo*, which the Basques regarded as mere equivalents of the former.

The *etcheco yauna* did not, however, enjoy any other privileges.* All professions were regarded as equally worthy of esteem, and none of them was considered to be derogatory to the honour of the individual who exercised it. It may easily be understood, therefore, how perfect a state of equality must result among all the citizens from such principles as these. Thus even at Saint Sebastian, when the *Ayuntamiento* gave a ball, no special invitation was issued, but a notice was merely posted up in the town containing the words "there will be a ball this evening," and those who liked took part in the festivity. Even in the present day, we meet with numerous traces of these patriarchal manners. These will, however, no doubt, gradually disappear as the Basques mix more and more with the neighbouring populations, and here probably, as elsewhere, the vanity of some and the jealousy of others will tend to establish more strongly marked social distinctions. Nevertheless, at the different singing classes and

* *Histoire des Cantabres.* This general equality is only characterised by one exception. Certain houses, called *infanzonos*, gave to their proprietors a distinguished place in certain churches, together with the privilege of having the bells tolled for them on their decease. It is, however, worthy of notice that these houses, which have been preserved with much care and pride in the same families, have almost all remained in the hands of cultivators of the soil, who in France would be regarded as holding the rank of mere peasants.

public assemblies on Sunday and other fête days, I have seen titled nobles mixing together with merchants and even with persons who amongst ourselves would rank very little higher than the common artisan. Marquesses and counts would figure in the same country dance with the tailors and haberdashers, and this admixture of ranks seemed to be perfectly natural to all parties.

The Basque *fueros*, which were exposed to serious risks during the Carlist war, have been preserved through the convention of Burgara and the prudence of the Spanish government, with the loss of two very unimportant privileges. The *Carabineros*, who performed the duties of the French *gendarmerie*, have been installed in the three provinces, while custom houses have been established through the provinces as far as the frontiers of France. But even in this respect a very marked distinction has been made in favour of the Basque provinces. Salt, sugar, and tobacco, which are subjected throughout the rest of the kingdom to a very high duty, are here almost entirely free. As in times past, the sovereign of Spain can neither raise men or taxes without the express consent of the states, and every attempt to establish any system of taxation or of conscription would very probably be followed by a new insurrection. When the Basques fought for Don Carlos with the cry of "*Viva el rey neto!*" Biscayans, Alavans, and Guipuzcoans were alike agreed in applying the term merely in the sense of the absolute king of Castille, who was nothing more than the simple Suzerain of the Euskaldunac. Their true battle cry,

the cry that alone appeals to their affections, is "*Viva los fueros!*"

A people amongst whom each individual can take part at any moment in the minutest details of the internal administration of the country, possesses true liberty and a true political existence. However great may be such a citizen's activity, he will always find full scope for its development, and he will exercise it wisely. The people will occupy themselves with their own affairs, and consequently they will think but little of those of their neighbours. Ready to resist every external aggression, they will be but ill disposed to become aggressors themselves. If, moreover, the constitution and customs consecrate amongst the members of this community a real equality resulting from a like condition of things, there will result from it a nearly uniform development. And such, in fact, is the picture presented to us by the Euskarian race. This race has never either been oppressed, nor has it oppressed others. It has neither been conquered, nor has it made conquests over others. Nowhere amongst this people do we meet with any painful contrast of extreme misery and exaggerated riches; a general competency, based upon the cultivation of the soil, seems at all times to have prevailed in this country, which owes its prosperity in part to maritime commerce. Admirably adapted for every profession which demands courage, address, and agility, the Basques continued for a long time to be esteemed among the best sailors in the world, and they still maintain their ancient reputation. In the middle ages, they alone knew how

to attack and overcome the whale, which was then very frequently met with in our seas. It was no doubt while in the pursuit of these animals, that they left along our coasts those colonies which, at the present day, in the midst of populations of very different origin, still present the incontestable impress of the Euskarian type.* The Basques carried their fishing excursions to very considerable distances, and they even frequented Iceland and Greenland at a very remote period; and if we are to believe some authors, they discovered the banks of Newfoundland and Canada about a hundred years before Christopher Columbus first set foot on the shores of America.

The Euskarian race is remarkable for the extreme beauty of its type, the principal ethnological characters of which are a rounded cranium, a broad and

* The inhabitants of some portion of the islands of the coast of Brittany and of several of the seaports of Normandy, no doubt owe the characters by which they are distinguished to a mixture of the Euskarian with the Celtic element. This fact appears to me probable in respect to the Island of Bréhat, and incontestable in the case of Granville. The women of this seaport bear the closest resemblance to the Basques both by their general physiognomy and by the beauty and special character of the face, but more especially by the graceful curve of the outline from the head to the bottom of the shoulders; and this last point of resemblance seems to be singularly characteristic. M. Vivien de Saint-Martin has made analogous observations on the fishing population of Boulogne, and he thinks even that the ethnological element of black hair which has mixed with the Celtic element of a light complexion at various points of the western shores of Europe, may be referable to an intermixture of the Basque type, and he thus approximates to the opinion of William Edwards, who characterised the inhabitants of certain districts in Brittany as Celto-Iberian.

well developed forehead, a straight nose, a very delicately chiselled mouth, an oval face, which becomes narrower towards the chin, large black eyes, black hair and eyebrows, a clear brown complexion, and an average sized but perfectly well proportioned figure, together with small and well shaped hands and feet. Owing to their seldom intermixing with other races, this type has been preserved, more especially in the mountains of Guipuzcoa and Biscay, with a surprising degree of purity. I have very frequently had occasion in crowded assemblies at Saint Sebastian to observe that for one somewhat homely face there were some twenty or thirty of really magnificent beauty.

The women more especially possessed in a high degree these characteristics of their race.* Their features, which are at once regular and animated, their large and expressive eyes, their delicately chiselled lips, which are almost always parted with a half sarcastic smile, and their long hair, which either falls in tresses nearly to their feet, or is wound round their heads like a natural diadem, combine to produce a picture which cannot fail to strike even the most careless observer. They are almost all distinguished for the delicacy of outline of the neck and shoulders, and this feature of beauty, which is generally of such rare occurrence, imparts even to the humblest peasant a certain air of grace and nobleness which even a duchess might envy. I do not exaggerate when I

* This is a fact which is well known to all ethnologists. The essential characters of the race are always more strongly marked and more constantly present in women than in men.

say that the carriage of those ragged *aguadoras* who support heavy pails of water on their head, presents the ease and almost the majesty of the Huntress Diana.

The men are perhaps less distinguished than the women for beauty of feature, but they are in no respect inferior to them in the elegance of their figures and the grace of their movements. With a red girdle bound lightly round his loins, his jacket thrown over the left shoulder like that of a hussar, with his cap set jauntily over one ear, and with a stick in his hand, the Guipuzcoan looks as if he were ever ready to leap rather than to walk, and when with head erect and a proud glance he salutes the passer by, one feels that there is a true courtesy in this act, which in other places is too often tinged with an air of servility. After I had become acquainted with this population, among whom each one knows how to maintain his own dignity while he respects that of others, I could better understand the spirit which had dictated the ancient charters that were granted to this race by the kings of Spain. Truly the Guipuzcoan Basques are a nation of *nobles*.

From my first arrival at Guettary, I had been struck by the fact that the men and women never join in the same sports on the Sunday. In the villages whither my geological expeditions led me, I had frequently had occasion to make the same remark, and I almost always found that while the men were playing at ball or at skittles the women were dancing by themselves. This condition of

things certainly exhibits a marked contrast to the habits observed among Celtic or Germanic populations.

The Basque mountaineers present another very characteristic and remarkable custom. When a woman is confined, the husband takes to his bed with the new-born infant, and there receives the congratulations of his neighbours, whilst the wife at once rises and busies herself with the cares of the household.* M. Chaho explains this singular custom by the legend of Aïtor. During his exile on the mountain, this father of the Euskaldunac had a son, and the mother fearing, if she remained alone with her child, that his life might be endangered, placed him under the care of her husband, while she herself went forth to seek the food necessary for the whole of the family. From this time the Basques have maintained this singular ceremony, in memory of the rude existence of their first parents. It will be readily understood that we can scarcely admit the truth of this explanation of a custom which is so contrary to our own habits, and we are more disposed to regard it as a remnant of that barbarism which is to be found among so many savage nations, where man as the *warrior* is all and everything, while woman is regarded as of no account.

* This strange custom exists among some of the tribes of Africa and among the savages of America. It appears also to have prevailed amongst the Tibari, a Scythian people who inhabited the borders of the Euxine Sea. It was also found, according to the testimony of Diodorus Siculus, in the island of Corsica. (Graslin, *De l'Ibérie.*)

The moral and intellectual characteristics of this people correspond entirely with their external appearance. A most remarkable degree of cleanliness, which strikes the traveller more especially among the French Basques, shows that the Euskarians possess that self-respect which is too often lost sight of by our peasants and working classes. The feelings of independence and of patriotism are the two great moving springs of their life. Proud of their origin, they despise all their neighbours whether Spanish or French, but the Castillians and Gallicians are more particularly the objects of their contempt. Enterprising and active, they are ever ready to leave their country, but it is with a view of returning to it after they have made their fortunes elsewhere. Capable of devoting themselves to the most assiduous labours, they soon become excellent workmen; and this quality alone, in an industrial epoch like the present, will probably secure at no very distant period to the Spanish Basque provinces a decisive preponderance over the other races inhabiting Spain.

Gifted with a lively and keen imagination, the Basques are naturally inclined to sportiveness and pleasantry. The instinctive love of poetry and of music, which is favoured by a language in which the same consonants recur at every moment, is very highly developed amongst them. Sometimes, on the occasion of a festival or fête day, the inhabitants of two different villages enter into a species of poetical contest. For days together the *improvisatori* of the two opposite parties challenge and reply to one-another in verse, which they either recite or sing to

those natural airs which are called *sorsicos*. The least event is often made the theme of a song, which circulates through all the neighbouring district, and this often becomes a very formidable weapon, which serves to punish many small misdemeanours. For example, every betrayed or deceived lover composes a song on the conduct of his mistress, and for some time she can scarcely appear abroad without hearing her infidelities warbled aloud by every mischievous urchin whom she encounters. This abundance of compositions has perhaps a special inconvenience of its own, for the latest productions soon obliterate the older ones, and of the many songs which were translated to me, there was only one which presented true characters of antiquity.* At the present day

* I have thought that my readers might be interested in becoming acquainted with this ballad, which I first communicated to my learned confrère, M. Ampère, and which was judged worthy of being introduced into the *Recueil des Chants nationaux* published by the Government. The translation was given to me by the woman who sung it.

The Maiden of Santa Clara.

"Although no hand of man has touched them, the church bells of Ataratz are tolling mournfully. To-morrow departs the maid of Santa Clara. Great and small are mourning, for to-morrow departs the maid of Santa Clara. Gold is gleaming on her saddle, and silver is shining on the trappings of her steed.

"My father, thou hast sold me into Spain, as though I were a cow. If my mother had been alive as thou art, my father, I should never have gone to Spain, but I should have been wedded within the castle gates of Ataratz.

"At the castle of Ataratz two oranges are blooming, and many have come to beg them of the Lord of Ataratz. But the answer has always been that the oranges were not yet ripe.

we must penetrate to the recesses of the mountains if we would find some old man who is still acquainted with those ancient ballads which date from the time of Charlemagne or the Roman epoch*, and which narrate the early traditions of the Euskaldunac.

"My father, let us depart in joy, for thou wilt return with tearful eyes and saddened heart, and often wilt thou go forth to watch the stone on thy daughter's grave.

"My sister, mount thee to the turret window, and see if Egoua, the wind of the south, is blowing, or if Iparra, the south-west breeze, is stirring. If Iparra be stirring, go bid him greet Sala, my lover; but if Egoua is blowing, bid him tell Sala to come and seek my body.

"My sister, haste thee to find me a snowy white robe, but do thou deck thyself in a garb of black.

"She dons her snowy white robe, and her sister decks her in a garb of black. She mounts to the turret window, and looks abroad for Sala. She sees him coming from afar, she throws herself from the turret window, and she falls dead. No one can raise her body; Sala alone can lift it."

* The most ancient monument of Basque literature is the *Song of Lelo*, discovered by Wilhelm von Humboldt, and which relates to the wars maintained by the Cantabri against the Romans, under the reign of Augustus. Without venturing to affirm that the poetry is really contemporaneous with the events which it records, Fauriel refers it to a very high antiquity by comparing it to another heroic song of 1322. The customs of which I have spoken in the text, appear to me to confirm the opinion of the celebrated historian of southern songs. The following is the ballad, which I borrow from the translation in the work of M. Mazures on Bearn and the Basque provinces.

"Strangers from Rome would subdue Biscay, but Biscay raises the song of war. Octavius is the lord of the universe, but Lecobidi is the Lord of the Biscayans.

"From the sea and from the land Octavius presses us closely. The arid plains belong to the Romans, ours are the woods and caves of the mountain fastnesses.

"Standing on well chosen ground, each of us is of stout heart.

Having been continually surrounded by Basques for nearly eight months, I had little difficulty in collecting numerous ethnographical observations in reference to this race; and during my stay at Saint Sebastian my time continued to be divided between the rocks and the sea in the same manner as at Guettary. Having been specially charged by the Museum to collect our littoral fossils, which had hitherto been very imperfectly studied, I devoted myself with assiduity to the search for these remains, which are the true archæological documents that have been bequeathed to science by the creations which preceded our own on the surface of the globe. In this respect, I could scarcely have been better situated, and from the first day of my arrival I found good reason to hope that I might successfully fulfil the mission that had been entrusted to me. In pursuing my investigations in the valleys around Saint Sebastian, I discovered several hitherto unexplored beds, and very soon my boxes were well filled with fossil plants, radiated animals and molluscs, while even the bay itself furnished me with some of my most curious specimens.

Our terror flees away when we measure arms with the foe, but alas our bread panniers are well nigh empty.

"If our enemies wear hard cuirasses, our defenceless bodies are nimble and agile. For five years, day and night, has the siege continued without rest or break.

"For one of our men that falls, fifteen of theirs are stricken down. They are many, we are few — at length we have made peace.

"The strength of the hardiest oak dwindles away as it grows higher up the mountain side. The city of the Tiber is far distant, but Uchain our chief is great."

Among the latter, there is one that demands special notice. On a stone which had been recently detached from the calcareous strata of Point Antigua, I found the perfect cast of a gigantic articulate animal, a worm which must have been several feet long, and more than one inch broad. The outline of the body, the walls of the intestine, and the membranous partitions in the interior, could be clearly distinguished on this fragment of rock, which in my eyes possessed as great a value as a newly discovered and perfect medal could have in those of an antiquary. Unfortunately, however, this magnificent specimen was inclosed within the stonework of one of the public dry docks, and I could not here make use of my hammer without special authority; but thanks to the activity of our consul M. Tastu, all difficulties were soon removed, and M. Peroncelli, the chief engineer of the province, came to preside in person over the removal of this precious relic. At the present day it forms a part of the collections in the Museum, and every one who examines it may recognise not merely external characters but even anatomical arrangements, which prove that thousands of years before the existence of man the type of the Articulata numbered upon our globe representatives which bore a great resemblance to those of the present day.*

* We have a great number of fossils belonging to the tubicolous Annelids with solid tubes, like the Serpulæ, but very few are to be met with belonging to the naked and soft bodied errant Annelids, like the Nemertes, &c. It is evident that it could only have been under favourable circumstances that the mud, hardened by the

My first zoological excursions were very unsuccessful. The sea, like the earth, has its times of repose, and when I arrived at Saint Sebastian at the beginning of winter I was at first fearful that I should not meet with any good subjects of study. The laminated rocks of Point Antigua, and the sands and muds of the Urumea, exhibited numerous traces of the presence of marine animals, but their tubes and galleries were for the most part empty; their inhabitants having migrated to greater depths.* I was already trembling at the thought of my probable want of success, when, in one of the small and narrow gulfs which are enclosed by the harbour between the mountain and the hills, I found pieces

action of time, could preserve this mould, and hence fossils of this kind present a very great interest. I do not believe that any of those which have hitherto been discovered afford us any insight into the anatomical organisation of the Annelids of these ancient seas. In this respect, the specimen which I brought from Saint Sebastian may perhaps be regarded as unique of its kind. Unfortunately, however, the rock in which it was deposited is very friable, and the voyage has to a certain degree injured some of the minuter details which could previously be traced with the greatest exactness.

* These migrations of the lower animals are as yet very imperfectly known. I have on different occasions observed that they were as rapid and as general as those of animals which occupy a higher place in the scale of being. Thus, for instance, at the end of October, at different points of the coast of Normandy, one is often unable to find a single sea urchin where perhaps a week before they might have been gathered by thousands. I have made a precisely similar observation in respect to one of the most remarkable Annelids of our coasts. We see, therefore, that these Radiata and Articulata possess the same instinct as many birds which, on the approach of winter, abandon mountainous heights and seek refuge in the plains and valleys.

of wood, that had been perforated by wide and deep galleries. I at once recognised the work of the Teredo, and having soon discovered the animals themselves, I was fully reassured as to the future success of my expedition, and I felt that two or three months would scarcely be too much to devote to the thorough investigation of this singular and too celebrated Mollusc.

The Teredo is an Acephalous Mollusc belonging to the same class as the Oyster, Mussel, &c., and yet at first sight there seems to be no resemblance between them. Imagine to yourself a kind of worm of a somewhat greyish white colour, which is sometimes as much as a foot in length, and from six to eight lines in diameter, one extremity of which terminates in a sort of rounded head, whilst the other is like a bifurcated tail. Such is the aspect of a perfectly developed Teredo when removed from its tube. The part which I have called the head consists of two small valves, something like two halves of a deeply notched nut-shell. These valves are immoveable, and only protect a small part of the body properly so called. The liver and the ovaries lie in contact with one another, very far back and behind the rudimentary shell, whilst the branchiæ are placed in the posterior part of the body. The mantle, forming a sort of fleshy case, envelopes all the viscera, and afterwards divides into two tubes, which the animal extends or contracts at will. One of these tubes serves to introduce the aerated water, which bathes the branchiæ, and carries to the mouth the organic molecules, which are necessary for the nutrition of

the animal, while the other throws off the exhausted water, which collects in its passage the residue of digestion. Thus, in the Teredo, the organs instead of being placed side by side are arranged behind one another, and this circumstance necessarily induces important modifications in the form, proportions, and general relations of these animals. Nevertheless, although this organisation may appear extremely strange at first sight, it is fundamentally the same as that of all the Acephala, and the philosophical anatomist will have no difficulty in detecting in the Teredo the essential character of the general type.

When we examine the delicate and fragile shell, the semi-transparent tissues, and the soft body which is almost incapable of motion, we can hardly conceive that the Teredo is an object to be feared; and yet this Mollusc is one of the most formidable enemies of man. The Teredo attacks submerged wood somewhat in the same manner as the larvæ of insects which are vulgarly known as worms attack wood that has been exposed in the open air. Imagine what would become of our trees and furniture, and of the supports and joists of our roofs, if they were to be gnawed by worms measuring a foot in length. If we supposed this for a moment we could better understand the damage which these obscure miners perpetrate by their stealthy and silent operations. In a few months, or even a few weeks, thick planks or piles of the strongest oak or pine, which to all appearance are perfectly sound, are sometimes found to be so completely excavated that, unable to offer further resistance, they yield to the slightest shock.

Thus large openings have suddenly been made in ships at sea beneath the feet of the sailors, utterly unsuspicious of the danger to which they were exposed, and at the beginning of the last century one-half of Holland was nearly engulfed in the waves, in consequence of the piles which supported her large dykes having all been destroyed and undermined by the Teredos.

Only one method has hitherto been proposed as a prevention against the recurrence of similar disasters, and this is by investing all submarine wooden structures with a complete metallic casing. The object of coppering the bottom of ships is chiefly with the view of protecting them against the attacks of the Teredo.* Unfortunately, however, this method is inapplicable for structures of submerged wood which every year pay a very considerable tribute to these destructive Molluscs. In our own day, however, science places at the disposal of industry many valuable resources which were unknown to our forefathers, and I believe it will be found very easy to destroy the Teredo within a given space, and consequently to protect our wharfs and other wooden structures from the attacks of these animals.

The process which I am about to describe is con-

* According to some experiments made in England, wood that has been long macerated in a solution of corrosive sublimate is not perforated by the Teredo. This mode of preserving wood is probably too expensive to be employed on a large scale. It seems to us, however, that thin planks that had been thus prepared might be employed for the bottoms of the small coasting vessels which frequent the ports which are infested by these Molluscs, and this method would probably be cheaper than the use of copper.

nected with some of the most intricate points of zoology, being based upon the study of artificial fecundation. Here, however, it will be necessary to enter into a few preliminary and explanatory details.

After they have attained the adult state, the Teredos live secluded within their galleries, which being lined with a calcareous matter secreted by the animal itself, have no communication with one another. This circumstance led to the Teredo being classed among those animals which are at the same time male and female; but although this opinion has been generally admitted it is not founded on fact. Here, as in many other cases, nature has solved the problem proposed to her in a manner wholly at variance with our preconceived ideas. Notwithstanding the cenobite life which the Teredos lead they are of distinct sexes. At an epoch which varies according to the species*, the females emit their eggs, which are arrested within the folds of the respiratory organs. Within this singular nest the young animals are born and live for a certain length of time under a very different form from that which they subsequently acquire.† At the moment when they

* It was long believed, and seems still to be the opinion of some naturalists, that our seas only possess one species of the Teredo. This, however, is evidently an error. At Pasages, I found two perfectly distinct species. The one kind ceased depositing its ova towards the end of October, after which time all the larvæ which I found in the branchiæ were already living and capable of independent motion. The other probably lays its eggs in the spring.

† This kind of incubation is common to many other Acephalous Molluscs. The Anodonta and other fresh-water Mussels may serve

are about to experience their last metamorphosis, the young Teredos leave the branchiæ of their mother, and, fixing themselves upon the first piece of wood that presents itself, begin to construct their galleries, and from this moment they are entirely protected from all external attacks. It is therefore necessary to destroy them before this period, or, what is at once more certain and more economical, we must *prevent their birth.* To attain this object it is sufficient to dissolve in the water which the mothers respire, an infinitely small quantity of a salt of mercury, lead, or copper.

Physiology teaches us that the egg, or female element, produced by the mother requires to be brought in contact with a special element secreted by the male, in order that it may be fertilised and become developed into a living being. In all animals that have hitherto been examined, this secretion when observed under the microscope has been found to contain minute organic particles which move with extreme rapidity. When submitted to the action of various reagents, these corpuscles comport themselves in the same manner as the Infusoria; various poisonous agents and electric shocks at once putting a

as examples. The eggs, or rather the young which proceed from them, pass the whole of the winter in the branchial folds of the mother. I was enabled for several months to follow the development of these Molluscs, of which I kept several by me in a tub of water. The memoir which I published in reference to this subject in 1839, was the first which I addressed to the Academy of Sciences at a period when I certainly had no hope that I should ever attain a place among that distinguished body.

stop to the rapid movements to which we have already adverted.

Led astray by these experiments, the first observers looked upon these corpuscles in the light of true animalcules, but a more profound investigation of the subject has now given us more correct ideas in regard to their true nature. These minute bodies are produced by special organs, in the same manner as the simple granular cells, which are so abundant in the fluids of living beings. They are to a certain degree organs, but organs which are charged with the accomplishment of their functions externally to the animals from which they emanate, and which for this purpose receive a certain share of vitality, which enables them to move for some time very nearly in the same manner as the tail of a lizard that had been separated from the remainder of the body.

These corpuscles are the active and immediate agents in the fertilisation of the eggs. To them is entrusted, so to speak, the accomplishment of the process by which the conservation and perpetuity of all animal species are maintained. Anything that arrests their movements and destroys their vitality obviously prevents them from exerting the mysterious power to which we have referred. Now in the Teredos, this fertilising fluid is as it were emitted at random: the organic particles disseminated throughout the mass of the surrounding water are carried away by the currents, and some of them thus make their way into the branchiæ of the females, where they meet with the eggs which they vivify by contact. If we

could only destroy the vitality of these organic particles before they come in contact with the eggs, we could at once put a stop to the further development of these destructive Molluscs.

I convinced myself by repeated experiments that a twenty-millionth part of a mercurial salt, if thrown into the water in which myriads of these organic corpuscles were moving, would be sufficient to render all of them motionless in the course of two hours. A two-millionth part of the same salt produces the same effect in forty minutes, and entirely deprives the water of the fertilising power with which it had previously been so highly charged. Without presenting equal intensity of action, salts of copper and of lead possess a similar property. To preserve the submerged wood of our marine docks and wharfs, it is therefore only necessary from time to time to throw a few handfuls of these different substances into the surrounding water. Fecundation would thus be entirely arrested, and the eggs would perish before they were developed, and consequently the species would be completely exterminated in our harbours and docks in the course of two or three seasons. By preventing the loss which is annually occasioned by the Teredos the original cost of this process would very speedily be more than covered.*

* The first expense would be merely to enclose the water within a circular wall, and this would obviously not be a very costly process. It will, of course, be impossible for me in the present place to enter into any practical details, but if everything should happen on a large scale in the same manner as in my experiments, one pound of corrosive sublimate, or two pounds of acetate of lead, would

The Hermellas of Guettary and the Teredos of Saint Sebastian were admirably adapted for experiments on artificial fecundation. All that was necessary to secure a supply of thirty or forty thousand eggs was to open one male and four or five females in a vessel filled with sea-water. This *accouchement forcé* in no way interfered with the success of the experiment. In a few moments vital activity began to manifest itself, and in the course of fifteen or eighteen hours every ovum had become an active larva, which swam about in all directions. By the aid of the microscope I frequently examined the succession of phenomena which brought about this marvellous result, and while my eyes were following the slightest appreciable modifications, and my hands were engaged in tracing the drawings which were intended to represent what I saw, my mind was busily engaged in considering all the great questions of natural philosophy, which are suggested by the study of embryology. It would be alike difficult and out of place were we to enter upon the consideration of all the problems which have been advanced or solved by this study. We will here merely consider those which precede the first rudiments of the nascent organisation. Let us enquire whence comes the germ of the new being? what are the general laws which preside over its development? what is the probable part played by the two elements, which almost always intervene to

suffice to destroy all the organic corpuscles contained in more than twenty thousand cubic yards of water; but it is probable that this proportion would require to be augmented.

secure the perpetuity of species? and let us be careful in this investigation not to separate plants from animals, for in the two kingdoms of nature inert matter after being vivified by life rises to a state of organisation under the control of the same laws.

Every living being is produced from an egg, or, to adopt the axiom of Harvey, *omne vivum ex ovo.* If by this word we understand something that is always identical with and more or less similar to the egg of the bird, the inaccuracy of the aphorism would be evident. A plant is multiplied by seeds, buds, bulbils, cuttings, &c., and animals present to us precisely analogous facts. If, for instance, we take one of those fresh-water Hydras, which are so common in our ponds, and cut it in pieces, we shall find in the course of a few days that each fragment has become a complete individual. This is a reproduction by cuttings. If we observe the same Hydra in the vessel into which we have thrown for its nourishment the larvæ of Insects or of Naïdes, we shall perceive that at one time it will lay eggs covered by a solid shell, that is to say, it will produce true animal seeds; while at another time it will give off buds, which grow, become more and more organised, and at length appear in the form of a young Hydra furnished with all its organs. At first adherent to the parent, and in direct communication with it, this newly formed being in all respects resembles a parasite, and is like a tender branch which derives all its nourishment from the trunk. After a few days, when the mouth is formed and the arms have grown longer, the young Hydra begins to seek for prey on its

own account, and thus contributes towards the general maintenance, in the same manner as the developed leaves of the young branch extract their portion of nutrient elements from the atmosphere. The branch, indeed, never leaves the stem from which it sprang, while the Hydra, on the contrary, after having attained sufficient size, separates itself from the body which had previously nourished it, and begins to lead an entirely independent existence. In addition to the seed, properly so called, which reproduces the plant, and the bud which becomes developed into a branch, there exists in certain plants a kind of intermediate structure, which is the *bulbil*. It resembles an ordinary bud in its composition, but, like the seed, it must be detached from the plant and developed apart from it, before it can give origin to a new individual. Animals in the same manner exhibit reproductive bodies, which are at once allied to buds by their structure and to ova by their functions. Let us examine some of these Synhydras, a kind of polype which I found on the shores of the Channel. You will often observe on some old and worn shell a somewhat thin stratum of a fleshy substance, bristling with small protuberances, and held together by a network of horny matter. This is the polypary, or common body to which the entire colony is attached, The animals, which are very similar to our fresh-water Hydras, have an elongated body, terminating in a mouth which is surrounded by six or eight moveable tentacles, which fulfil the functions of arms and hands. Narrow channels, forming a network, pass from one individual to the other, and maintain a communication between all the digestive cavities, so that the

nourishment taken by each polype tends to the direct support of the entire community. This animal is multiplied in three different ways.

From the fleshy polypary of which we have spoken are given off *buds*, which increase and become organised in the same manner as those of the Hydra, but without ever leaving the place of their birth. They therefore comport themselves precisely in the same manner as the branches of a tree.

In the thick substance of this same polypary are developed *eggs* properly so called, and these eggs, when they are ejected from the body within which they took their origin, comport themselves in the same manner as the seed, which is developed and propagates the species after separation from the parent plant.

Finally, a certain number of individuals are destined to generate deciduous buds or true *bulbils*, the propagation of their species being the only function which they have to fulfil; they have neither arms nor mouths, and are nourished by their neighbours. These ovoid buds are detached from the parent stock at certain epochs, and are carried away by currents. Many no doubt perish, but those which encounter a favourable locality become fixed, and, in a few days, after undergoing elongation, give birth to a polype which is at first isolated, but afterwards becomes in its turn the original stock of a new colony.

We see, therefore, that there is not so great a difference between the seed and the vegetable bud, or between the egg and the animal bud, as we might at first have been led to suppose. In these two kingdoms of nature the bulbil occupies an intermediate

position. We may, however, employ a more general term to designate these different reproductive bodies, and define them in a more precise manner. The bud is a *germ* which requires for its development that it should adhere to a parent which does not in reality deserve the name either of male or of female; the bulbil is a *germ* which is detached from the parent, and is developed without fecundation; whilst the egg is a *germ* which for its development requires the concurrence of the two sexes, and is also detached from the parent.* Finally, then, every living being proceeds from a pre-existing germ, and such is in fact the true translation which we ought to give of the Latin aphorism to which we have already referred.

It would be impossible to give a detailed report of all that has been said on the origin, nature, and mode of development of these germs. Absurdities and incongruities abound in most of these reveries, of which only a very small number deserve the title either of a hypothesis or of a system. To give a general idea of the conceptions of the human mind on this subject, we will refer to three leading doctrines, which have been supported by celebrated physiologists, who have attempted to establish an accordance between their theories and the science of the time. These are the doctrines of *evolution*, of *accolement* (Buffon's theory), and of *epigenesis*.

* It is now well known that the viviparous as well as the oviparous animals proceed from an egg. The only difference between these two modes of development is, that in the former case the egg is detached from the ovary, and undergoes development within the body of the mother.

According to the system of evolution, germs are as ancient as the world itself. In other words, God in forming the universe created simultaneously all the organised beings which were to people it to the end of time. Each of these germs is, in short, either a complete plant with its roots, trunks, branches, and leaves, or a perfect animal, which is deficient in no respect, not even in a hair or a feather. When placed under favourable conditions, this kind of *animated miniature* grows, it is true, but it never adds the slightest new part to those which it has possessed from the creation of the world.

Up to this point the evolutionists are tolerably unanimous, but all accordance disappears among them when they are called upon to explain the actual distribution of these germs. Some, as Bonnet, hold that these infinitely small germs, which are by nature indestructible, are everywhere diffused. They maintain that they circulate in the sap of trees and in the blood of animals, being always ready to become either wholly or partially developed, either for the sake of giving birth to an embryo, or of reproducing some organ that has been lost by the living being which encloses them. The young bird and the young mammal are germs which have undergone a complete evolution: the claw of the crab which has been reproduced after having been torn off; the head or the tail of the worm which is reproduced after having been severed from the rest of the body, are the claw, head, and tail of so many germs, which profit by the opportunity of developing a portion of their being, whilst the rest remain in a rudimentary state.

Other evolutionists, and amongst these we are sorry to have to place the great Haller * and Cuvier

* Haller was born at Berne in 1708, and died in 1777. He was one of the most distinguished scientific men of the eighteenth century, and nature appears to have been most bountiful to him in every respect. He was, at once noble, rich, and handsome, and he moreover was endowed with a very uncommon degree of mental power. From the age of nine, he began to distinguish himself, and at a very early period he was admitted as member of several scientific societies. The rest of his life was in perfect accordance with this beginning, for he devoted his time almost exclusively to science, poetry being the only relaxation in which he indulged. Two odes which he composed are said to have been remarkably good, one being "On the Alps," and the other "On the Death of his Wife." Haller spoke almost all living languages, and wrote equally well in German, French, and Latin.

Having been appointed at a very early age as professor at the University of Göttingen, he continued for seventeen years to occupy the chairs of anatomy, surgery, and botany. Several sovereigns endeavoured to attract him to their courts, but having been nominated member of the supreme council of his native town he returned to Berne, where he received all the honours at the disposal of a republican government. Haller having been attacked by the disease to which he afterwards succumbed, devoted his attention to the study of his own symptoms, recording the progress of his malady and the progressive failing of his vital forces, until the moment when his pulse had nearly stopped, when a sign to the friends who were standing round him indicated that he had maintained his presence of mind to the very last moment of his existence. Cuvier, who has recorded this remarkable example of moral courage, exhibited in his turn a precisely similar instance of consciousness and self-possession.

The works of Haller are very numerous; but although the greater number of them relate to medicine and human physiology he did not neglect the natural sciences properly so called, and he deserves to be regarded as one of the founders of comparative physiology. His great work, which appeared under the modest title of *Elementa Physiologiæ Corporis Humani*, will always be regarded as one of the noblest monuments of human intelligence, while his *Opera Minora*

himself, admit that germs are only to be met with in certain organs. Now as a germ can only enclose its descendants in the same organ in which it was itself contained by its predecessors, it results, if we admit the first proposition, that the germs of all past, present, and future generations have been and still are contained within one another by *emboîtement*. According to this hypothesis, an animal may be compared to a sort of juggler's box, and when a new individual is produced it is simply as if one of the double bottoms of the box had been removed. The mere enuciation of such views is sufficient for their refutation.

The doctrine of Buffon, to which the term *accolement* is applied, is not more rational. According to this illustrious naturalist, there exists in nature a *primordial matter*, which is alike common to animals and plants. This matter is composed of living, incorruptible, and ever active *organic particles*. These universally diffused particles serve for nutrition and growth, while the surplus of what is necessary to attain this result is transmitted from all parts of the body into certain organs specially destined to serve in the place of a reservoir. When these molecules are arranged in a suitable place they exercise a sort of elective affinity. All those which come either from the foot or the hand, attract one another reciprocally, and become aggregated together, whilst they maintain the order which they previously

will continue to be consulted, if for no other reason, for the observations which they contain in reference to the embryology of Birds and Mammals.

occupied. Consequently they reproduce on a small scale the internal mould or cast of which they themselves had formed a part. We see that in this hypothesis, the new being can only be formed by the aid of materials which have been directly furnished to it by each of the organs of the parents, and consequently the children of a one-armed parent could not possess two arms.

This objection, suggested by common sense, did not prevent the ideas of Buffon from being adopted or reproduced with certain modifications even in our own day, under the sanction of several distinguished physiologists. Oken, amongst others, the patriarch of the *Natur-Philosophie* school, admits the existence of a *primordial mucilage* very similar to the *primordial matter* of the French naturalist, whilst he assigns to the Infusoria a part which is very nearly identical with that of organic molecules. According to him all living beings are merely aggregations of Monads, chained together by an archetype, which gives to them their form, and if the Monads themselves appear to be produced in animal or vegetable infusions, it is only in consequence of their having been set at liberty.

In the doctrine of epigenesis, or super-formation of parts, which is almost universally admitted in the present day, it is held that no appearance of the new animal is to be found in the perfect impregnated egg before the commencement of incubation, but that when the formative process is established under the necessary favourable circumstances, the parts of the embryo are gradually put together or built up by

the apposition of their constituent molecules. Hippocrates, with his penetrating genius, gave a clear enunciation of these views when, in speaking of the formation of man, he compared the embryo to a tree, and the different members or viscera to the branches and stems which are successively added, to the trunk. In this doctrine every *birth* is to a certain degree a *creation,* and every new individual is truly a *product* of the individual by whom it has been generated.

Many naturalists have maintained that the future embryo may be traced solely to the male, and is primarily an organic corpuscle (in the case of animals), or a grain of pollen (in the case of vegetables), which penetrates into the ovum or ovule of the animal or the plant, and here becomes developed as in a kind of *nidus.** According to these, the female is entirely passive, and is merely a kind of animated hatching machine, somewhat more perfect perhaps than the ovens of the Egyptians or our own model Eccaleobions.

* These views have never had many adherents among zoologists, and although attempts have been made to reproduce them in the present day it is not probable that they will meet with greater success. The mass of facts and of precise observations that may be opposed to them is too great to be set aside by a few exceptional cases that have been observed in the eggs of a very small number of animals. The case is different, however, in respect to botany. Schleiden, one of the most celebrated German botanists, has exhibited considerable talent in developing the doctrine to which we refer, and his theory has been almost universally adopted in his own country. French botanists, after remaining doubtful for a time, are now tolerably well agreed in opposing these views, chiefly in consequence of some most conclusive observations which are more especially due to M. Tulasne, who mainly owes his recent introduction to the Academy of Sciences to his able researches on this difficult subject.

More precise information and more exact methods have, however, overthrown these hypotheses. After having for a long time attempted to supply the deficiencies of science by mere creations of fancy, and after having endeavoured to explain that which did not admit of explanation, embryologists have turned in our own day to rigid experiment and observation.

Under the guidance of these, we learn that in the two kingdoms of nature, epigenesis, or *successive formation*, is the great law, which presides not only over the development, but over the very organisation of germs. Buds, bulbils, eggs, or seeds, in short all reproductive bodies, are produced from a pre-existing individual being, which elaborates them from its own substance, under the influence of vitality, and in consequence of phenomena of nutrition and secretion similar to those from whence result all the other products of the organism. At first imperfect, these germs are successively completed, and only become capable of fulfilling their important functions after they have attained to *maturity*. Some, as we have already remarked, possess in themselves all the vital activity that is necessary for their development, in which case, properly speaking, there is neither father nor mother; others, on the contrary, require the intervention of a special agent, and here first appear distinct sexes which concur in the reproduction of their species.

In the plant as in the animal, the female secretes a germ that must be fertilised, while the male produces the fertilising agent. From the contact of these two elements there results a new individual.

In the animal and the plant the bud is *living*, because it is simply a portion of its parent. Again, in the animal or plant the bulbil is *living*, because when separated from its parent it grows and is developed. The seed and the fertilised egg are equally *living*, although both may for a more or less considerable length of time present all the appearances of inert matter. Is the egg which we keep for household purposes *dead?* By no means, for if it were placed under a hen that was sitting it would give birth to a chick. Were the cereals which were found in the tombs of Thebes *dead?* By no means, for when they were thrown into the earth they germinated and produced plants similar to the progenitors which had disappeared from the face of earth for thirty or forty centuries. In both cases life was in a *latent* condition, and required for its manifestation a concurrence of favourable circumstances.

The observations which I have made on the Hermellas throw considerable light upon some of the difficult points to which I have already reverted.

On leaving the body of its mother the egg of the Hermella is composed like all perfect eggs of four distinct parts, that is to say, of a yolk or vitellus, a germinal vesicle or vesicle of Purkinje, placed in the interior of the yolk, a germinal spot enclosed within the vesicle, and finally of a very fine membrane which envelopes the whole.* The germinal spot and vesicle are two minute transparent globules, while the

* In the eggs of birds, the white or albumen and the shell are merely accessory parts, which are formed in the oviduct after the actual egg has left the ovary.

yolk is formed of very minute opaque granules, united together by a perfectly diaphanous *matrix*.

If we throw one of these eggs into sea-water, in which some of the male organic corpuscles are moving, we shall see, after a few moments' immersion, that it has become the seat of a condition of vital activity which may be easily watched through the microscope. A mysterious force seems to mould these elements, blending them together on all sides.

The yolk presents alternating movements of contraction and expansion; the spot and the vesicle successively disappear; a transparent globule escapes from the midst of the vitellus, and then begins the singular phenomenon discovered by MM. Prevost and Dumas.* A circular streak is observable round the vitellus, which divides spontaneously first into two, and then into four parts, and goes on subdividing thus successively, until it is only composed of very minute globules. In proportion as this cleavage progresses, the granular character of the vitellus diminishes, and finally disappears. The entire mass assumes the appearance of young tissues. At this period, we soon begin to perceive a few small filaments, which are at first immoveable, but speedily begin to strike the liquid with jerking motion. These filaments become more and more multiplied when the young Hermella after having balanced itself for some time, as if to try its nascent organs, suddenly leaves the solid plane which supported it

* The cleavage of the vitellus, which was originally discovered by physiologists in the egg of the frog, has since been observed in all animals that have been investigated under favourable conditions.

and throws itself into the liquid under the form of a small and irregularly spherical larva, bristling all over with vibratile cilia.

Such are briefly the phenomena presented by the fertilised egg of the Hermella. In twelve or at most fifteen hours, this *egg* becomes transformed into an *animal*, which swims about, stops and guides itself, and thus gives evident signs of spontaneity. The same egg, if left in the liquid without being brought in contact with the fertilising element, becomes decomposed in about forty or fifty hours. We must not, however, suppose that it is the less active on this account. The characteristic activity of the first phases of development are manifested here no less than in the fertilised egg. The yolk dilates and contracts, the spot and vesicle disappear, the vitellus undergoes cleavage, and becomes thinner. For the first few hours it is almost impossible to distinguish a fertilised from a non-fertilised egg. In the latter, however, the movements increase in rapidity while they diminish in regularity, and instead of resulting in the *organisation of a new being*, they terminate in the *destruction of the germ*. If, however, we take some of these eggs which seem very nearly decomposed and bring them in contact with the fertilising corpuscles, their movements will slacken and become more regular, and we may even frequently obtain numerous swarms of larvæ from eggs that have been deposited for nearly forty hours.

These facts, which I have repeatedly verified, appear to me to be thoroughly conclusive. They teach us that the movements, which have their seat

in the egg immediately after its appearance, are entirely independent of fertilisation. The disappearance of the germinal spot and vesicle, the oscillations of the yolk and its cleavage, are, in the isolated female element, so many signs of special activity, and of a vitality which belongs to it. When these movements cease, and when the egg becomes decomposed, it is in reality *dead*.

Thus the fertilising corpuscles, after separation from the male, retain a certain amount of vitality. In the same manner, on their separation from the mother, the eggs possess a special and individual life. Even in non-fertilised eggs, this vitality is manifested by spontaneous and characteristic movements, precisely the same as we observe in the case of the male corpuscles. In the latter, all indications of vitality disappear in a comparatively short time, and it is precisely the same in respect to non-fertilised eggs. In the fertilised eggs, on the contrary, vital movements are prolonged, and result in the complete organisation of a living being. The contact of the egg with these corpuscles is not, therefore, to give or to re-awaken a life which is already present in the egg, and which is manifested by appreciable phenomena, but rather to regulate the exercise of this force and thus to secure its duration.*

* Several naturalists have observed the movements to which we refer in non-fertilised eggs, but pre-occupied with the idea that the male organic corpuscles were necessary to *vivify* the germ, they have ascribed these movements to incipient putrefaction. The experiment which we have described must, however, completely set this view at rest, for it is obvious that eggs, whose chemical composition had begun to be affected, could not possibly be re-

Under the influence of fecundation, all the parts of the egg of the Hermella and of the Teredo are changed into an animal. The entire mass of these parts is transformed into tissue, the external membrane becoming the skin of the new being. Here we have in truth a *metamorphosis* in the strictest sense of the word. As phenomena more or less similar to those which we have sketched occur in all species, whether oviparous or viviparous, it follows, that this expression, which has been proscribed by evolutionists, ought rather to be generalised and applied to the development of all living beings. Embryology might, properly speaking, be defined as the *science of metamorphoses.*

The word *metamorphosis* would here assume a general sense, and would designate the succession of epigenetic facts, which produce from the germ either a perfect plant or animal. Hitherto, however, it has only been applied to those very apparent modifications which are experienced by certain animals after their escape from the egg, and we will therefore employ the term in its ordinary signification. Even in this restricted sense, the phenomenon of metamorphosis is much more common than is generally supposed. It was long regarded as a characteristic of the class of Insects and of the group of the Batra-

organised so as to give birth to larvæ. Since I published these researches, the results which I obtained have been confirmed by different observers. I had even an opportunity of thoroughly demonstrating this fact to some of my colleagues, in the case of the eggs of the Unio, in which these phenomena are very well marked, although perhaps they are not so striking as in the eggs of the Hermella.

chian reptiles.* At the present day, however, it has been found to occur in a great number of the Articulata and in most Molluscs and Radiate animals. In proportion as this remarkable phenomenon is observed in more numerous and more varied types, it exhibits itself under an entirely new light. For example, it was formerly believed that the object of metamorphosis was always to raise the organism to a more perfect condition. Such is indeed the case in respect to the tadpole that becomes a frog, and to the caterpillar which is changed into a butterfly, but the result is often precisely the reverse. By the very fact of metamorphosis, the organism becomes degraded, and the adult animal only retains faculties which are inferior to those of its larva, as if the butterfly were to become a chrysalis.†

We will now consider what takes place in the case of the Teredo.

The larva, which is at first almost spherical and entirely covered with vibratile cilia, may be compared to a very minute hedgehog, in which every spine acts as a natatory organ. It swims in all directions with extreme agility, and this first state continues about a day and a half. Towards the end

* Frogs, Salamanders, &c. These animals are the only ones belonging to the type of the Vertebrata which present true metamorphoses.

† Milne Edwards has proposed to apply the term *recurrent types* to those animals in which the very progress of development seemed to result in the organic degradation of the individual. One of the best examples that we can give, independently of the Teredo referred to in the text, is that of the Lernea, to which I have already alluded in a preceding note.

of this time, the external skin bursts, and after being incrusted with calcareous salts becomes a shell, which is at first oval, then triangular, and at last very nearly spherical. While the shell is being formed, the vibratile cilia disappear, but the little animal is not on that account condemned to inactivity. In proportion as the external cilia diminish, we observe that another equally ciliated organ becomes developed, which widens and extends in such a manner as to form a large ruff or collar margined with fringes. This new organ of locomotion may be entirely concealed within the shell, or may be extended from it, and acts in the manner of the paddle-wheel of a steamboat.

By means of this apparatus, the young larva continues to swim with as much facility as in its earlier age; but it now moreover requires another organ, which enables it to advance upon a resisting plane, as, for instance, to rise along the side of a glass vessel. This is a sort of fleshy foot, very similar to a long and very mobile tongue, which can be extended and contracted at will. The larva of the Teredo possesses moreover organs of hearing similar to those of several other Molluscs, and eyes analogous to those of certain Annelids.

During this period of its existence, our Mollusc therefore enjoys to a high degree the characteristic faculties of a *living being*. It moves, and is brought in relation with the external world by organs of the special senses. Now, however, comes a last metamorphosis, and this same Teredo loses its organs of motion and sensation, becoming a kind of inert mass

in which vegetative life replaces almost entirely the active spontaneity of the animal.

If I have not fallen far below the task which I had proposed to myself, even those among my readers who are the least familiar with zoological science will now be able to understand some of the attractions which belong to these embryological investigations. The birth and development of a germ, and the metamorphoses of the being which derives its existence from that germ, are objects which cannot fail to interest all those who are capable of thought and feeling. The crudest facts have in themselves often an immense interest in consequence of the questions which they raise or solve, but even beyond the modifications of form, and the transformations of matter, it is impossible not to recognise something infinitely superior. Everywhere in these phenomena *life* appears as a distinct force, acting with one special object which could not be attained by any other agent, giving rise to germs, and fashioning each one according to its species. While it is always one and the same in its essence it is infinite in its manifestations, enveloping inorganic and dead matter in the rich mantle of organised creation. We may recognise this force by its effects, but we shall doubtless always remain ignorant of its nature. Here we are most assuredly touching upon the profoundest mysteries of this world; for beyond this primary cause there is nothing but *the Cause of causes*, — there is nothing but God.

CHAP. IX.

THE COASTS OF SAINTONGE.

LA ROCHELLE.

Journey from Paris to La Rochelle.—Historical notice of that town: its origin; its constitution; its sieges.— Decay of La Rochelle.— Poverty of the coast; reciprocal dependence of the kingdoms of nature. — The Branchellion; its external characters; its lymphatic respiration. — The natural method; insufficiency of the principle of dominant characters in the study of the lower animals.

A MERE glance at the geological atlas of France will suffice to show that our western coasts present two totally different varieties of geological structure. At the extremity of Normandy, along the whole length of Brittany, and on a considerable part of Poitou, the ocean strikes upon a coast line consisting of schistous or granitic rock; while from Talmont as far north as Saint Vaast nothing is to be seen but limestone, which finally merges in sand and alluvial deposits. The pursuit of marine animals had first led me to the shores of the central mass of our continent; subsequently I explored those of the Basque country and the Channel. In all these different regions, the animal populations, or, to use the current expression, the *faunas*, appear to me to present characteristic differences corresponding to the nature of the geological strata. I felt that to confirm this general fact it would be necessary for me to visit

some intermediate point most likely to furnish the data necessary for a rigorous comparison. I had recourse to my usual councillors, the geological atlas of MM. Dufrénoy and Elie de Beaumont and the hydrographical atlas of M. Beautemps-Beaupré, and from the indications afforded me by these works I was induced to set forth for La Rochelle. It was in 1853, on one of those gloomy evenings, which, by the cold dampness of the atmosphere, made one feel as if autumn had supplanted summer, that our diligence was put upon the railway. At Saumur, our vehicle was suffered to resume the use of its four wheels, and at break of day we were passing one of those military roads which have opened the way into the recesses of ancient Vendée. Like many other useful things in this world, our road was of a very modest and unassuming kind, for it never attempted to oppose or overcome the obstacles that lay before it. Yielding to every accidental rise and fall of the ground, it wound at one moment along the base of a shady valley, at another round the sides of a hill empurpled with flowering heather. An August sun was rising above the horizon, gilding with its rays the foliage of a grove of chestnut trees, and illuminating with its brightness masses of granite which had witnessed the first cataclysm that had rent the crust of our globe. The genial warmth soon restored sensation to my stiffened limbs, and awoke a thousand sweet sounds of birds and insects. Amid the rattling of our wheels and the tinkling of the small bells that adorned our horses, I felt the calm and solitude around me in the same manner as at Paris I have been conscious, amid the stillness of my own chamber,

of the distant hum that betokens the vicinity of a busy and crowded city, and soon the bright sun, the songs of the birds and the calmness of the scene, filled my heart with a sentiment of happiness and profound peace, which after a time seemed even to extend to my travelling companions, who certainly were amongst the most stolid and sullen individuals that I had ever encountered.

I reached La Rochelle before night, and on the following morning I hastened to pay my respects to the elder M. d'Orbigny, one of the veterans of marine zoology.* Like all men who have worked hard themselves, M. d'Orbigny gives a hearty welcome to all those who follow in his own steps. On the strength of my title of a naturalist I was received as an old friend. I soon made the acquaintance of several men devoted to the study of the natural sciences, and in their company I visited the Museum, in which they have made a most interesting collection of the different productions belonging to the three kingdoms of nature which are to be ob-

* M. d'Orbigny, who originally practised as a physician at Esnandes, and subsequently at La Rochelle, has devoted himself with the greatest enthusiasm and perseverance to the study of natural history. Not contented with collecting and describing a great number of marine animals, he was one of the most active correspondents of Cuvier, and it is to him that the town of La Rochelle owes in a great measure the foundation of its provincial museum. The four sons of M. d'Orbigny have all devoted themselves in various ways to the study of their father's favourite science. M. Alcide d'Orbigny has acquired a distinguished reputation by his travels in South America, and by the important palæontological memoirs which have led to his nomination to the rank of professor at the Jardin des Plantes.

tained in the department of the Lower Charente. Having examined the local fauna, I at once understood the nature of the district that I was about to investigate, and was anxious to begin my labours without delay. Unfortunately, however, it was neap tide when I arrived, and as the sea scarcely uncovered more than the highest zones of the beach, which was very poor in animal life, I found no opportunity for some time of pursuing my zoological investigations. To occupy this forced leisure, I turned my attention to the past records of La Rochelle, and began at once to study the history of this city, which would very probably have played as great a part in history as any of the Italian republics if it had not been nearly crushed between France and England.

Like Venice, La Rochelle has risen from the midst of the sea, and has been peopled by the proscribed of other nations. The ocean, which once advanced far beyond its present limits, surrounded on three sides a low rock,* forming a small elongated cape, which appeared to emerge from the midst of vast morasses. A few cottages grouped together round a tower adjoining a chapel, and inhabited by poor fishermen, were built on this islet, and such was La Rochelle until the beginning of the twelfth century. At this period, the serfs of Chatelaillon and Montmeillan, fleeing from their native territory, which had been

* This rocky ledge, on which were constructed first the tower, and subsequently the castle, gave to the town the Latin name of which its present name is a mere translation, namely, Rupella, or little rock.

laid waste by war and overwhelmed by the sea, sought refuge on this far distant promontory. They were joined by a colony of *Colliberts,* who had been driven out of Lower Poitou, and in 1152 the population had so much increased that it was found necessary to build a new church.* From this period the importance of La Rochelle increased rapidly. After his marriage with Eleanor of Aquitaine, Henry II., anxious to secure the fidelity of a town that was peopled by bold seamen and rich merchants, raised it to the rank of a commune and granted it very considerable privileges. At a later period, Eleanor accorded them fresh immunities, and organised that energetic and active municipality which successfully struggled against so many crowned heads, and which subsisted for more than 400 years.†

The municipality of La Rochelle was composed of twenty-four *eschevins* and seventy-six peers, appointed for life. This kind of senate was recruited, in case of vacancies, by election, while moreover they every year selected from their number three candidates, from among whom the king or his representative was compelled to choose the mayor, who, during the term of his office, exercised sovereign power. The king of France, it is true, appointed a lieutenant-

* *Histoire de la ville de La Rochelle et du pays d'Aulnis, composée d'après les Auteurs et les titres originaux,* by M. Arcère, 1756.

† The constitution of La Rochelle was fundamentally modified by Francis I. in 1535, and re-established in its primitive form thirteen years afterwards by Henry II. Independently of this temporary suspension it continued almost unaltered from 1198 to 1628.

general in civil and criminal matters; but this functionary could levy no tax, and his prerogatives were limited to the nomination of the mayor and to the presidency of the Rochellais tribunals. The military governor, who was also nominated by the king, could not issue any orders to the town militia, nor cause a single soldier to enter into La Rochelle without the permission of the mayor and the *eschevins*. It is evident, therefore, that in regard to these privileges, La Rochelle was a true republic, as free, and, in reality, as independent of the crown, as the great fiefs themselves.

By means of these institutions and the remarkable men who were placed at its head, La Rochelle soon assumed very considerable importance. At once commercial and warlike, it was able, when the occasion demanded it, to convert its trading-vessels into ships of war, while its sailors were as speedily converted into soldiers, who, from the time of du Guesclin to the days of the Duke de Guise, merited the epithet of *rusés soudards* and *braves gens*. Thus too, in the middle ages, it repeatedly played a very important political part. It made an honourable peace with the king of Arragon, repulsed the English, to whom the city had been surrendered by the treaty of Brétigny, and afforded aid to du Guesclin. Again we see it resisting the English and the Bourguignons during the insanity of Charles VI., while it furnished Charles VII. with the fleet by which he was enabled to reconquer Bordeaux. During this long period the spirit which animated La Rochelle continued unchanged, and may be expressed in these words—

unlimited attachment to its privileges, and unalterable fidelity to the sovereign who respected them. The republic claimed as an honour its title of vassal of the crown, but in return it exacted that the sovereign, before he entered its walls, should swear to respect its liberties. On this condition alone the mayor cut the silken cord which was suspended before the city gate, while on the same condition La Rochelle pledged herself never to aid the enemies of France with men or money, and always to remain a faithful and serviceable ally of the sovereign — a compact which she faithfully kept. The advance of society and the antagonism of religious creeds at length, however, severed a bond which for three centuries had been consecrated by devotion on the one hand and friendly protection on the other. La Rochelle having become a stronghold of protestantism, the Count de Montmorency, one of the generals of Charles IX., severed the cord that had been respected by so many kings, and entered the city without having tendered the usual oaths of good will. This was a signal for a war, which was sometimes carried on openly and honourably, and at other times covertly and treacherously; but throughout this long contest, which endured for nearly a century, La Rochelle maintained the struggle always with honour, often with success. Indeed she seems to have drawn an additional degree of energy from the association of a new faith with her antiquated form of policy. Twice the entire army of France was ranged in order of battle before her walls, and when at length she succumbed, it was to

no weaker power than the inflexible and persevering genius of Richelieu.

Among the events which signalise the mournful period of our religious wars, there are scarcely any which equal in importance the two sieges of La Rochelle by the royal troops. The Massacre of Saint Bartholomew, on the 24th of August, 1572, had placed the Rochellais on their guard, and on the first news of this fearful event they prepared courageously to defend their lives and religion.* The mayor, Jacques-Henri, placed the city in a state of defence, and armed all the inhabitants. Paris, Orleans, Tours, Bordeaux, Castres, and Nîmes, sent reinforcements of Calvinists who had escaped the sword of the assassins, and these refugees constituted a formidable body known as the *enfants perdus.*

The territory of La Rochelle was indeed speedily invaded, and the city closely invested by the royal troops under the command of the Duke d'Anjou. With him were also present the Duke d'Alençon, his brother, and Henry of Navarre, together with the *élite* of the French nobility, including the Prince de Condé, the Dukes de Nevers, Longueville, Guise, and Mayenne, with the Duke d'Aumale, the Catholic hero of "La Henriade," to whom Charles IX. had confided the direction of the siege. The attack on

* *Histoire du siège de la Rochelle par le duc d'Anjou en* 1573, by A. Genet. The author of this narrative, which is composed from a purely military point of view, combines together all the documents that have been left in relation to this siege, and it is from this writer and from Father Arcère that we have extracted the materials employed in the above narrative.

the city was begun on the 15th of February, 1573, and was carried on for four months with unparalleled valour and obstinacy on both sides. At length in the middle of June the Duke d'Anjou made one great concentrated assault upon the city, but having been seven times repulsed, he finally ordered a retreat to be sounded, and confessed himself vanquished. These repeated checks had brought the royal army to a state of hopeless demoralisation. Disease was raging in the camp and decimating the soldiers, whilst even their bravest captains were discouraged at the hopeless progress of the siege. The Duke d'Anjou, who had lately been elected king of Poland, and in whose camp were the ambassadors charged with the duty of conveying him to his new states, earnestly desired to come to some arrangement which would save appearances and enable him to depart. The queen-mother, Catherine, who felt that the glory of her favourite son had been tarnished by the result of this prolonged siege, caused negotiations to be seriously entered into between the belligerents, and, as a first pledge of the good faith of the royal party, the Rochellais received a promise that the besiegers would destroy all their works. Soon after this, Charles IX. was compelled to sign one of the most favourable edicts that had as yet been obtained by the reformed party, for the Rochellais not only secured liberty of conscience for themselves, but stipulated that the same privileges should be accorded to all those who professed the reformed faith in France.

Unfortunately this peace was as hollow as those which had preceded it, and hostilities soon recommenced, in defiance of treaties. Although these dissensions were suspended as long as Henry IV. lived, they revived almost immediately after his assassination by Ravaillac. The construction of Fort Louis, which commanded the town, became an incessant cause of uneasiness and irritation to the Rochellais. Although every new treaty contained a special clause for securing the demolition of this citadel, it nevertheless continued to exist, recalling to mind the gloomy prediction of Lesdiguières, that either "the town must swallow up the fortress, or the fortress would swallow up the town." At length, in 1627, Richelieu appeared before the gates of La Rochelle, and in a very few days the inhabitants saw that the ancient republic of Eleanor was drawing near its end. The issue of this second siege destroyed the last stronghold of the Protestants, and compelled them forcibly to submit to one common law with their Catholic brethren. From this time forth protestantism was simply a religion, and ceased to constitute a political watchword.

The siege of 1573 was tinged with the character of an age in which the traditions of chivalry were not yet wholly effaced. It was purely by force of arms that the captains of the Duke d'Anjou had attempted to reduce the rebel city. Prodigal of their own lives, they had shown very little care for those of their soldiers. The fury of the attack and the energy of the resistance explain the nature and enormous amount of the losses experienced by both

parties, although more especially by the royal army*, while at the same time they enable us the better to appreciate the result of the undertaking. This mode of fighting left some chance to heroism, and this chance had been in favour of the Rochellais.

To imitate the Duke d'Anjou would have been merely to have run the risk of encountering the same obstacles and meeting with the same reverses. Richelieu, who had determined to destroy in France the Protestant party which he upheld in Germany, followed from the first a totally different system of tactics. In order to leave nothing to chance in this terrible game of war, he changed the siege into a blockade. By his order a trench six feet deep and twelve feet wide was cut for a distance of twelve miles around the suburbs of La Rochelle, terminating at both extremities at the entrance of the bay. Behind this trench rose a parapet, flanked by seventeen forts and a great number of redouts armed with formidable artillery. Forty thousand chosen men, under the command of the most skilful generals of France, were encamped beyond those lines, with orders not to fight excepting to repulse the sorties of the besieged; and the severe punishments which were inflicted on those whose ardour led them to

* The troops of the Rochellais amounted to about 3100; of these about 1300 were killed in the course of the siege. The royal army amounted to 40,000 men, of whom 22,000 were killed; more than 10,000 fell in the trenches or in the different engagements that took place between the besieged and the assailants. The loss on both sides was therefore nearly proportional to their numbers, and from these data it would appear that the siege cost the lives of nearly half of those who took part in it.

disobey these commands, soon taught the army that this prohibition was one which could not be safely trifled with.

Having made all his arrangements on the landside, Richelieu next turned his attention to the sea. The bay, at the termination of which the town is built, separated the two extremities of his lines by a channel of about 1500 yards, which the ships of La Rochelle entered notwithstanding the fire of the batteries and forts, and which consequently might be entered by the English, the doubtful allies of the city. Richelieu determined to bar the passage, and under his directions stakes were driven in, vessels filled with stones were sunk, and on the top of this foundation a dyke was raised whose height exceeded the elevation of the highest tides. The narrow passage which was left in the middle was protected by two accessory piers, armed with two forts, and by a triple row of ships of war, which were always ready for action, while stakes were fastened together by iron rings, and ships at anchor were ranged with their prows turned towards the open sea, and armed with long spikes for the purpose of arresting fire-ships or other combustible matters that might be sent against them. Richelieu then waited with that patience which the certainty of success alone can engender.

In fact the fall of Rochelle was a mere question of time. Its inhabitants, who were thus completely cut off from the rest of the world, very soon exhausted all their provisions. The famine became horrible, and the details that have been transmitted to us in reference to the subject by several eye-witnesses are truly

frightful. After having eaten the most loathsome animals, and attempted to substitute pounded bones and sawdust for corn, and leather or parchment in the place of meat, the Rochellais attempted to cheat their hunger by devouring plaster and grated slates. Many fed upon the bodies of the dead, and one woman died in the act of devouring her own arm. The bodies of the dead encumbered the streets and remained unburied till they were entirely decomposed. The living, who were covered with a black skin, through which their bones protruded, experienced the most horrible pain on the slightest touch. Towards the close of the siege, 400 persons died daily, and when, after fourteen months and sixteen days' blockade, Louis XIII. made his entrance into La Rochelle he could not restrain his tears at the sight of so much suffering, although precautions had been taken to render the spectacle as free from horror as possible. Only 5,000 Rochellais received him and implored his pardon and favour; out of the 28,000 inhabitants which the city had contained at the beginning of the siege 23,000 had died of famine.*

A whole population seldom attains this degree of heroic constancy, if it be not sustained by some noble spirit who can inspire them with his own energy. Such a man was Jean Guiton. Descended from a family of *eschevins*, and the son and grandson of mayors, this celebrated Rochellais had at first exclusively occupied himself with the cares of business and the

* A thousand persons died from the effects of their privations after the surrender of the city, and there remained therefore only about 4000 of the original population of La Rochelle.

management of a somewhat impaired fortune, but having been named admiral at the age of thirty-nine, he at once displayed the greatest military talents, and a most indomitable firmness.* He had begun by attacking the royal fleet, which was twice as strong as his own, and after putting it to flight, had captured several vessels. Next, with 5000 men and 500 cannons, he attacked the Duke de Guise, whose vessels were at once larger and better armed, carrying 14,000 men and nearly 650 cannons. This was a most sanguinary battle. 14,000 discharges of cannon were made in two hours, and both commanders incurred the most imminent peril. Night interrupted this unequal struggle; but instead of profiting by it to escape, Guiton and his Rochellais remained in battle array, ready to recommence hostilities in the morning. By break of day news arrived that peace had been signed. Then Guiton went to salute the Duke de Guise, and offered him his standard as the representative of the king of France. Guise refused it, declaring that he had not gained it. He embraced Guiton, and said to the Rochellais captains, "Vous êtes de braves gens d'avoir ozé combattre si vaillamment; c'est à quoy je ne m'attendais pas, et estimais que, voyant une armée si puissante, vous deussiez vous retirer sans combattre." "Monseigneur," answered Guiton, "jusqu'ici Dieu m'a faict cette grâce de n'avoir jamais tourné le dos au combat, et je me fusse plustôt perdu par le feu que de fuir."

Such was the man whom the Rochellais chose for

* *Jean Guiton, dernier maire de l'ancienne Commune de La Rochelle*, by P. S. Callot, ex-mayor of the city, 1847.

their chief, when after having been besieged for nine months and having exhausted all other resources, they wished to strengthen their own courage. It required more than ordinary devotion to accept a duty like this, and we can scarcely wonder that Guiton should at first have hesitated; but when once he accepted the charge confided to him, he never wavered for a moment. In the midst of the most horrible scenes, he always showed himself calm and almost cheerful in his bearing towards his fellow citizens. He managed everything both in regard to the internal administration, the defence of the city, and the negotiations which were being carried on both with England and the king of France. By day he presided over the councils, visited the sick, and consoled the dying, and at night he made the rounds and himself gave orders to those on guard. Some few citizens, bewildered by suffering, and fully conscious that it was he alone who prolonged this desperate resistance, attempted to set fire to his house, and even endeavoured on several occasions to assassinate him. Guiton, although he had no mercy for spies and traitors, contented himself with committing them to prison, and pursued his unswerving course. At length, having twice seen the English fleet approach the roads without making any attempt to aid them, after having ascertained that a treaty had been signed by which these faithless allies left them to the mercies of Richelieu*, and finding that

* It is easy to perceive, from reading the details of the negotiations which took place before and during the siege, that the English government had expected to find among the inhabitants of La

his garrison was reduced to seventy-four Frenchmen and sixty-two Englishmen, Guiton felt that he had done enough, and had exacted from his compatriots all that was humanly possible; he therefore now came forward and entreated them to surrender to the king, and laying aside all personal feeling went and himself liberated from prison one of his greatest enemies, the assessor Raphael Colin, and entrusted to him the command of the city, in order the more effectually to facilitate the conclusion of the treaty.

The conditions were extremely severe; for although life, property, and liberty of conscience were granted to the few surviving Rochellais, all the privileges of the city were annulled, and it was stipulated that the ramparts and other defences of La Rochelle were to be entirely destroyed.* The mayor and ten

Rochelle a sentiment of animosity against France, or at all events against the king, which they were very far from entertaining. Buckingham probably hoped by the aid of religious dissensions to bring back those times when England possessed one of the finest districts of France. These hopes were, however, frustrated by the cordial patriotism of the Rochellais, and when the fact was once ascertained, a marked coolness was exhibited towards them by the English. The armaments which had been promised to them, and the reinforcements on which they had relied, never reached them. Finally, the want of success which attended the expedition conducted by Buckingham himself on the island of Ré, in 1627 (in which he was repulsed by Toiras, and defeated by Schomberg), thoroughly disgusted him with the war, and he concluded a separate peace with France without informing his allies of the step he had taken.

* These conditions which were granted by Richelieu when all further resistance was absolutely impossible, exhibit the real character of this struggle. It is evident that it was more especially of a political character, at least in the eyes of the leaders of the opposite parties. If the Cardinal had acted in accordance with the

of the principal burgesses were at first exiled, but they returned some time afterwards, while Guiton took service in the royal navy with the rank of captain. He died at La Rochelle at the age of seventy-nine, and was interred near the canal of La Verdière, where had stood the ramparts which he defended with so much constancy, and close to fort Louis, which had been the cause or pretext of those wars in which he had so signally distinguished himself, and within sight of the dyke which completed the ruin of his native city.

With the exception of Colin and a few compilers who have blindly followed his statements, all writers are unanimous in their appreciation of Guiton; Catholics and Protestants, priests and laymen, all alike agree in rendering homage to the magnanimity of his character and the nobleness of his heart.* Hence his name has always been popular at La Rochelle, where the marble slab is still shown on which he struck his poignard when he swore to defend the city to the utmost of his ability. A proposal was made in 1841 to erect a statue to

catholic spirit of his age, he would not have left the Rochellais to the free enjoyment of their own mode of worship. If the municipality had considered its religious faith before its municipal rights, it would not have taken those minute, and occasionally even offensive precautions against the English, which afford the only explanation of the strange and somewhat ungenerous conduct of Buckingham and his successors towards their allies.

* During the siege some fanatics offered on different occasions to assassinate Richelieu. Guiton rejected these offers with indignation, giving utterance to his refusal in nearly the words of the minister Colbert: "It is not by such means that God will deliver us."

Guiton, but the existing government refused to ratify this vote of the municipal council of La Rochelle.

It is difficult to explain the motives of this refusal, for if it were from the apprehension of seeming to sanction a revolt, the fear was entirely unfounded, for Guiton and his fellow-citizens cannot in any respect be regarded as rebels. They demanded nothing more than the execution of a contract that had been ratified by many successive kings, and sanctioned by the authority of ages, and which moreover they had always faithfully observed. During the whole of the siege the *fleurs de lis* were respectfully preserved on the city gates, and every day through the sorest times of the famine they prayed to God for the life of the king. But their fidelity was subordinate to their attachment to their ancient privileges, and the latter being irreconcilable with the progress of society, and with that spirit of fusion or amalgamation of different parties in the state which was accelerated by the powerful hand of Richelieu, they were necessarily doomed to perish. La Rochelle had incontestably ancient rights on her side, whilst the Cardinal might invoke the aid of the new order of things; and perhaps we may be permitted to say that in this sanguinary conflict the attack and the defence were equally legitimate.

La Rochelle has never entirely recovered from the terrible blow inflicted by the hand of Richelieu. At different times its relations with Canada, the coasts of Africa, or Saint Domingo, have restored commerce and riches to her walls, and in our own

day its well-known medicinal salts, brandies, and various fishing expeditions, bring numerous ships into the harbour, but the population has never approximated to its original numbers. It has been at once reduced and transformed, for La Rochelle contains now only 15,000 inhabitants, of whom only about 800 are Protestants, while there is scarcely a family that can trace its genealogy as far back as the time of the sieges. The persecutions which began as soon as the Calvinists were no longer to be feared, the revocation of the Edict of Nantes, and the emigration to which it gave rise, and lastly mixed marriages, which have almost always been contracted to the advantage of the dominant religion, have combined to bring about these results.

The town itself is but little changed; the streets are still bordered with porticoes or low galleries, which entirely conceal the pedestrians, and give to the city a desolate and sombre aspect which completely harmonises with the puritanical austerity of the original builders. The *Hotel-de-Ville*, with its smooth stone façade, with its fortress-like gate, its two towers, and its rows of battlements and loopholes, is a faithful representation of the *Maison Commune* of those haughty merchants who fought under Morisson and Jean Guiton. But the ramparts which once protected the city have all disappeared with the exception of three towers preserved by Richelieu as citadels, and subsequently connected with the fortifications which were erected in accordance with Vauban's plans. On a hill whose summit commands the harbour and the town stands

a cheerful country house with an adjoining farm and gardens, enclosed between a line of low hillocks. These hillocks, which are every year being more and more levelled by the action of the plough, are all that now remains of Fort Louis, which according to the prediction was to have swallowed up the city, and it is only with difficulty that the eye can trace by a few irregularities of the soil, the plan of the glacis and the lines of its trenches. The dyke has been better preserved; for although the winds and the waves have demolished the summit and rendered the sides less steep, its foundation stones may still be seen at low water, running out from the shore in a long black line, which still seems as if it would bar the entrance to the harbour.

The neap tides, which had opposed so decided an obstacle to my zoological excursions, did not, however, prevent me from traversing the coast day by day in order to form some idea of my prospects of success, and certainly my first explorations inspired me with very serious apprehensions on this subject.

My preceding researches had shown me that limestone is infinitely less rich in marine animals than schists and granites. The greater softness of this stone prevents it from resisting a purely mechanical shock, even when it occurs in compact masses. Besides this, the chemical composition of limestone enables the water to dissolve a portion of it, which although inconsiderable is not the less appreciable. On this account the Algæ and Fuci, which on the shores of Brittany cover the granite with detached clumps or extended sheets of verdure, cannot attach

themselves securely to these surfaces, which are always being broken up, and on this account they are of much rarer occurrence. With their disappearance, numerous species of animals vanish from sight which either feed upon these marine plants, or find a retreat within their branches. The same conditions oppose similar obstacles to the multiplication of Zoophytes and other fixed animals. With the herbivorous species and with those which are stationary in the manner of plants, all the carnivorous species also disappear which live at their expense. If, moreover, the limestone happens to be formed of fissured strata, which the waves can easily break up, the preceding causes exercise a still stronger action, while, moreover, those animals which usually conceal themselves or at any rate deposit their eggs within the recesses of the rock, diminish in their turn from the want of safe retreats. Finally, if these strata form inclined planes towards the sea, the springs in the neighbouring district follow these water-courses, and bursting forth in streams along the beach, diminish the saltness of the water which washes the shore and drive away all those animals which are more decidedly marine in their character.

It is obvious, therefore, that the richness and character of the littoral fauna depend upon the mineralogical composition and geological structure of the district. This is one of the thousand examples which show us how great an influence the mineral kingdom occasionally exerts over the two other kingdoms of nature, and how organised and living beings may be placed in a state of dependence on inert bodies,

and finally how all the links in the great chain of creation are held and bound together by one universal whole which constitutes the great end and object of the studies of the naturalist.

All these causes of depopulation were combined together in the environs of La Rochelle. Everywhere the oolitic limestone exhibited its shallow strata, broken in every direction and cut perpendicularly down by the action of the waves. At the foot of these cliffs, there usually extended a long line of the same rocks, formed into broad inclined tiers. Even on the most favourably situated points, I found a marine plant which from its colour and plaited leaves has been compared to our lettuce, and which only grows in brackish water; down to the very zones of the lowest tide-mark, this inauspicious *Ulva* formed vast beds, amid which the Fucus that had been closely cut looked something like badly grown chicory. One last sign, which was scarcely less unpromising than the preceding ones, made me tremble for the result of my expedition. Long experience had taught me that nothing is to be found in pure mud. Alike hurtful to the eggs and to the adult individuals, it destroys the former by preventing the oxygen from reaching the germs, while it is not suited for the habitation of the latter, which require a somewhat resistant soil through which to carry their passages and galleries.

Now at La Rochelle the mud invades everything, both the harbour and the bay; and it is scarcely possible for the sluices to keep a channel deep enough for the passage of trading vessels. Beyond this arti-

ficial canal, nothing is to be seen but a bed of black or yellow mud, which extends from the highest zones far below the limits of the lowest tides. There are even some uncovered spots, where one would have imagined that the waves would have swept everything away, yet here the mud is more than a foot deep, and covers with its thick mantle both sands and rocks, while it fills up every fissure and opening. The slightest agitation is sufficient to move the semi-fluid stratum, and indeed along the whole length of the coasts the water is almost always turbid, the slightest breeze of wind being sufficient to render it thick and to give it an appearance almost of solidity. Farther off land, the sea, without being much clearer, preserves something of its natural colour. Its blue, blending with the yellow of the mud, often changes into a fine green colour. At certain moments when the isolated clouds marble the ocean with their shadows, and a light breeze breaks the water into furrows, the play of the light upon the surface of the waves produces a strange illusion. It almost seems as if you were looking at a vast plain, the nearest portions of which consisted of freshly cut corn fields beyond which a rich tract of fresh meadows seemed to stretch to the very horizon.

Several causes combine to produce this accumulation of earthy particles in the waters of the Saintonge. From north to south, from Point Aiguillon to Point Fouras, the islands of Ré, Aix, and Oléron form as it were a kind of interrupted dyke, which runs along the shore, and is separated from it by an irregular canal, which is very much contracted towards

the south. Several rivers, amongst others the Charente, the Sevre, and the Saint Benoît, empty themselves into this basin, and their currents, which are opposed to each other owing to the situation of their mouths and the disposition of the coast, mutually neutralise one another. Thus the detritus, which has been carried away from the marshy districts through which they have flowed, is prevented from being discharged into the open sea.

The ocean on the other hand contributes in two different ways in maintaining and augmenting this accumulation of mud. For a considerable distance from the coast the sea is of very little depth, and its bottom, which is composed of strata very similar to those of the neighbouring districts, is readily influenced even by ordinary tides. The water flowing within the space inclosed by the islands and the coast penetrates into it by three straits *, and meets on its passage with submarine beds, from which it always takes up a certain amount of matter, while the currents, impinging upon one another, serve only to carry new detritus towards the shore. This cause acts with a very much greater force, when the wind, coming from the open sea, drives the high waves of the Atlantic against the coast. At this time, the bottom of the sea seems to be convulsed by the agitation of these liquid masses, whilst the cliffs, which are formed of yielding rock, giving way to the re-

* These straits are the strait of Breton, between the island of Ré and the coast; the strait of Antioche, between the islands of Ré and Oléron; and the strait of Maumusson between the islands of Oléron and the continent.

peated shocks which shake and undermine their base, fall away in large fragments, and mingle their *débris* reduced to powder with those which the waves have torn up from the very depths of the ocean. Thus we find along the whole length of this coast that the sea has been effecting the double work of accumulating mud and of breaking down the rocks—results which we may see confirmed at the very gates of La Rochelle.

My first researches confirmed but too well the discouraging presentiments with which the inspection of these coasts had inspired me. I was obliged to go to the lowest tide mark before I could meet with animals which elsewhere are found in the highest zones, and even there, although I worked diligently with my pickaxe and crowbar, I only found a few common species, which I recognised from having seen them both at Boulogne and Saint-Jean-de-Luz. After many equally unprofitable attempts, and finding that my bottles still continued empty, I gave up my ordinary methods of exploring, and tried what could be done by other means.

It was then that I had reason to congratulate myself for not having listened to the petty vanities of society or to self-love and a desire of ease, and that, faithful to the habits of a devoted labourer in the cause of science, I had avoided taking up my residence in the fashionable quarters of the city. The lodging which I secured was situated at the harbour, in a tavern which was chiefly frequented by the workmen of the neighbouring docks. My hostess, who was no longer young, was somewhat of a scold, and

without incurring the reproach of being over fastidious, I might have objected to the flavour of the viands and the amount of cleanliness with which my meals were served; but my room was large and light, and before me stretched the harbour with its three basins where I could see every barque that entered the roads of La Rochelle. I was in the midst of the fishermen and sailors, and by the help of some introductions, which are quite as necessary in such a case as in any other, I made the acquaintance of two masters of merchant vessels. I saw them very frequently, and took care always to pay them great attention. Doctor Sauvé joined his influence to my solicitations, and finally succeeded in bringing me a very curious animal, whose existence in the seas of La Rochelle had been one of the main inducements that led me to visit that place. A few details regarding this remarkable species will I hope make my readers comprehend that in the present condition of modern science, a little worm like this may not be an unworthy inducement to a naturalist to undertake a journey of 450 miles for the express purpose of studying its anatomy and internal organisation.

Those naturalists who, by combining a number of hitherto isolated facts into one general whole, elevated zoology into a true science, were necessarily led to direct their attention first to the best defined and most natural groups of *a fixed type;* consisting of animals whose anatomy indicated in the most decided manner a fundamental plan. When they encountered one of those groups of *a variable type,* in which the

species which appear to be most similar under certain relations differ essentially in respect to others, and when their scalpel was employed in the dissection of those animals which deviate abruptly from the neighbouring groups, appearing to form a distinct class, they passed over these exceptions, which were at first very rare, or endeavoured, as well as they could, to make them fall within their regular systems. This mode of studying animals could indeed only afford a key to a method of classification, and while it revealed the general tendencies of the organisation and inspired elevated views capable of embracing the entire animal kingdom in one vast and general whole, it necessarily was attended with very serious inconveniences. The science of living creatures was assimilated too closely to that of inert bodies, and because the latter presented a certain number of more or less rigorous laws, a premature attempt was made to proceed in the same manner in respect to descriptive zoology, anatomy, and physiology. Very soon zoology, like physics and chemistry, and almost like mathematics, had a certain number of formulæ, which were generally estimated at their right value by those who propounded them, but which many of their pupils and imitators soon converted into inflexible rules and incontestable truths.

Science, however, has always advanced, and it has been found necessary to admit that a great number of generalisations which had been taken for granted or recognised as facts thirty years ago, require in our own day a most severe revision. From hence has arisen that special interest which belongs to the

study of long neglected animal groups, and hence also has emanated a spirit of emulation which brings the naturalists of all countries to the sea-side, in search of the objects of their study. The marine faunas bear indeed very little resemblance to those of the land, or air, or fresh water. The sea contains entire groups belonging to special types which have no representatives elsewhere. Here live almost exclusively those singular beings which are often of considerable size, although the animal organisation is reduced to its simplest expression, seeming almost as if they were objects fitted by the hand of nature for elaborate experiments in physiology and which it is sufficient to know, recognise, and interpret. It is here more especially that we must seek those animals of abnormal external forms and exceptional organic arrangements which open to the student of nature vast and ever varied fields of inquiry.

Considered from this point of view, the *Branchellion* merits the serious attention of naturalists. This animal lives as a parasite upon the Torpedo, and is never met with elsewhere, a fact which, it may be observed, is in itself extremely curious. Every one is aware that the Torpedo is a living electrical machine, which has the power of striking its enemies even at a very considerable distance. Fishermen daily witness evidences of the singular faculty of this fish. As soon as it enters their net or *chalut*, they are made aware of the fact by the shocks which are transmitted through the tackle by which it is suspended, and I was assured that these shocks are often sufficiently violent to compel the men to let go

when they are drawing in their nets, and thus allow the whole haul to fall back into the sea. To enable the Branchellion to live with impunity upon the body of the Torpedo its organisation must render it insensible to electrical action, so as to allow this worm, which varies from an inch to an inch and a half in length, to resist the force of discharges which shake even the strongest man.

The Branchellion, which was first discovered by Rudolphi *, was classed by Savigny † among the

* Rudolphi, professor and director of the Museum at Berlin, is justly regarded as the founder of Helminthology. He has devoted almost all his life to the study of the Intestinal Worms. His principal works on this subject are entitled *Entozoorum sive vermium intestinalium historia naturalis*, and *Entozoorum Synopsis*, which will always serve as a point of departure for researches of this nature.

† Savigny, a member of the Institute, was born at Provins in 1777, and died at Versailles in 1851. Destined for the clerical profession, he commenced his studies in the College of the Oratorians, where he showed such aptitude for learning, that his teachers predicted for him a successful career in the church, but the Revolution changed the destiny of Savigny. At the age of sixteen, he came to Paris to attend the classes of the *École Normale*, and he then lodged in a garret in the Rue Copeau. He soon, however, made himself known by several memoirs on botany, in consequence of which he was appointed professor at the *École Centrale* of Rouen. At this time, however, Bonaparte was organising his expedition for Egypt. Cuvier, who appreciated the talents of Savigny, recommended him for the post of zoologist in association with Geoffroy Saint-Hilaire, and when he hesitated, on the plea that his studies had hitherto been of a different nature, Cuvier replied to him: "Partez, vous serez zoologiste quand vous voudrez."

Savigny justified this confidence both by his zeal and by the number and value of his researches. Having been commissioned to collect and study the Invertebrate animals, he not only traversed the whole of Egypt, but he advanced as far as possible along the coasts of the Red Sea, to observe the marine species which it

leeches. Cuvier, De Blainville, and their successors adhered to this arrangement, although its external

contains in such large quantities. He was at Alexandria at the period of the capitulation of the French army, and he was the first to respond to the generous enthusiasm which, initiated by Geoffroy Saint-Hilaire, enabled France to retain the fruits of her scientific conquests when all else was lost.

On his return to France, Savigny resumed his studies with redoubled ardour. While he was preparing his part of the great work on Egypt, he published in succession several memoirs on entirely new subjects, and it was then, in the very prime of life and with one of the noblest scientific careers open before him, that his labours were suddenly arrested. In 1817 he experienced the first symptoms of a singular malady, which partially disappeared with rest, but which having been revived by a premature application to study, changed the rest of his life into one prolonged scene of suffering. On the first symtoms of a relapse, Savigny understood the fate that awaited him. In a letter which he wrote to his fellow-citizens to announce the gift which he had made to his native town of Provins of his copy of the great work on Egypt, he himself related in the most touching manner the torments which he suffered. It would appear that the nerves of special sensation were morbidly affected; grotesque and often threatening visions rose before his eyes; voices, sometimes harmonious and sometimes discordant, were ever singing in his ears; and fetid odours seemed to be diffused around him.

If the unhappy Savigny retained his reason in this painful and terrible condition, and if he were enabled to the latest moment of his life to study and describe his sufferings, he owed this power in a great measure to the generosity of a friend who gave him for his residence a charming cottage near Versailles, and more especially to one of those manifestations of disinterested devotion of which women alone seem to be capable. For twenty-seven years Mademoiselle Letellier de Sainte-Ville shared his prison. Placed by the side of the wire screen, which closed the darkened chamber in which Savigny suffered, she watched over him, read to him, and kept him acquainted with the progress of science, and thus connected him with that world to which he could never return.

Although the active scientific career of Savigny was thus brought

characters ought of themselves to have raised some doubts on this head. Like the leech, the Branchellion is furnished at each of its extremities with a sucker, which enables it to affix itself securely, but the body, instead of being in a single piece, as is the case in all the animals to which it approximates, bears on its anterior extremity a kind of rounded enlarged and spindle-shaped neck, which is very nearly one-third of the whole length, whilst the rest of the animal, which resembles a dark violet coloured leech, presents on each side a series of thin laminæ widened in a fan-like shape, plaited on the edges, and of a lighter colour. By this division of the body into two very distinct portions, and by the existence of these appendages the Branchellion formed a solitary exception in the group of the Hirudineæ *, and by placing it in the same family, and side by side with the ordinary leech, De Blainville acted in direct

to a close before his life was half spent, and although he was never able to publish the greater part of the materials which he had collected, he must still rank in the number of the founders of modern science. Cuvier has gracefully characterised his labours in a single sentence: "Savigny ne découvre pas, il revèle," words which aptly express the unexpected nature of many of the results discovered by this naturalist. After an interval of twenty years we can fully confirm this judgment. The memoirs of Savigny on the Annelids, on simple and compound Ascidians, on the structure of the mouth of Insects, &c., are still the standard works on the subjects of which they treat, and indicate that their author possessed in an extraordinary degree a combination of those two rare properties, great power of observation and a spirit of generalisation which was at once bold and vigorous (see the *Éloge de Savigny*, by M. J. Geoffroy Saint-Hilaire).

* The name of the family, in which are included all worms that are allied to the leeches.

opposition to some of those principles which he had himself most strenuously advocated. The truth is, that in the presence of the great variability of the lower animals, even the greatest systematisers are forced to yield to evidence, and to renounce those arrangements which have been arbitrarily drawn up, and under which they endeavour to comprise the whole of the animal creation. The remarkable external characteristics of the Branchellion attracted the attention of anatomists, who were impressed with the conviction that it would be found to possess an equally singular internal organisation. Unfortunately, however, the Branchellion is not of common occurrence; indeed it is but rarely met with even in those places where the Torpedo is taken by hundreds, and yet it is impossible to make any accurate observations on the animal except in its living state. I knew from my own personal experience that no available results could be obtained from specimens preserved in spirits, for the alcohol hardens the animal, and confounds all its organs and tissues. I was not then acquainted with the works which had been recently published in Germany on the subject, and there remained therefore many questions for me to determine.* For instance, I was anxious to ascertain what

* F. Leydig, a distinguished naturalist, published, some time before my departure for La Rochelle, a very interesting notice of the Branchellion, which he had observed in the living state at Genoa. The results at which we both arrived agree in most points, although they differ on several. These differences are no doubt in part to be ascribed to the more favourable circumstances in which I was able to examine these animals, and perhaps also in part due to our having observed different species. Some details given by

were the lateral appendages which were placed on each ring like so many vertical fringes; were they simple cutaneous folds, as had been affirmed by Cuvier, De Blainville, and all their successors? were they the respiratory organs, as Rudolphi and Savigny appear to have conjectured them to be after the inspection of a single specimen? If this were the case the Branchellion would be a leech with branchiæ, that is to say, an animal of an exceptional kind, not only in respect to the family to which it belonged, but also in respect to the neighbouring groups. If we are to accept the principles of which I have already spoken in their strictest sense this would be as singular as if we were to meet with a mammal without lungs; and although we may observe in the lower animals very considerable deviations from their assumed normal types, this would be a most extraordinary deviation. Yet I learned from direct observation that such was actually the case, and repeated experiments fully confirmed this result.

When seen under the microscope these broad membranous laminæ, which appear to be so thin and of so simple an organisation, showed that they were protected by cutaneous strata, moved and kept open by muscular and ligamentous fibres, and animated by nerves. I further discovered ramified canals giving origin to a network permeated by a perfectly colour-

Leydig have led me to think that there may be two species of Branchellion, although only one species has yet been recognised. I brought the preparations with me to Paris which are necessary to demonstrate the exactness of all the essential facts which I obtained from my investigations.

less liquid which was loaded with very minute granules whose movements indicated those of the liquid itself. This characteristic structure was in itself sufficient to authorise us in regarding these appendages as true branchiæ, but I wished to obtain a more decisive proof for my own satisfaction and that of others.

By means of a finely pointed syringe, I injected into the canals which connect these appendages a precipitate of iron of a faint bluish colour, which has the property of becoming darker on being brought into contact with oxygen, and of becoming changed into a Prussian blue colour. I took care to select an animal that was full of life and activity, but although the operation was perfectly successful, I did not at first perceive any change; the colour of the liquid employed being concealed by that of the tissues. But very soon the air in the water which penetrated through the living tissues of the animal, acted upon my precipitate as it would have done upon the blood itself, and yielded to it its oxygen. I saw the appendages become rapidly coloured, whilst the vessels assumed the appearance of undulating lines of a blue tint,* which became every moment deeper, and in a very short time I could perceive their ramifications with a simple lens. This experiment was decisive. I had seen the Branchellion *respire the salt of iron,* if I may be allowed to use the expression; the appendages were therefore incontestably branchiæ.*

* In this experiment, the portion of the injected liquid which had penetrated into the interior of the body, did not present any change

Having once determined the part played by these organs, I had next to inquire what liquid it was that was exposed in them to the action of the air. This question may at first sight seem a singular one. Without any profound knowledge of natural history, and even without any acquaintance with medical science, most persons are aware that the blood is subjected to various alterations by the action of respiration, which is performed by lungs in Mammals, Birds, and Reptiles, and by branchiæ in the case of Fishes. Is there then in certain of the Invertebrata some other nutrient fluid besides the blood? and does this liquid require to be vivified by being brought in contact with the air? We reply in the affirmative to both these questions, and at once proceed to enter into a few details which may render this very important fact more easy of comprehension.

In all animals without exception the nutrient fluid, whatever may be its true nature *, becomes constantly exhausted by its sojourn in the organs, and repairs its losses by the materials furnished to it

of colour for more than forty-eight hours. This difference of time, together with the appearances presented by the lateral lamellæ, places the respiratory nature of the latter beyond all doubt.

The method which I employed to determine the function of these lamellæ might be adopted in many analogous circumstances. Considered from this point of view it would, I think, be found to be highly serviceable; for we are still ignorant of the exact point at which the respiratory process is effected in the case of a great number of animals.

* I have elsewhere endeavoured to show how the circulatory apparatus becomes successively completed, and how this progressive complication corresponds with the equally progressive character of the nutrient fluids.

by digestion on the one hand, and by interstitial secretion on the other. In Man and in all the Vertebrata, the blood thus receives the chyle and the lymph, and these two liquids, which proceed the one from the digestive organs and the other from all parts of the body, circulate in special vessels which communicate by a common trunk with the system of the blood-vessels. In consequence of this disposition or mode of arrangement, the chyle and lymph remain distinct from the blood and the other liquids which bathe all our tissues.

In the Invertebrata there are no lymphatics or lacteals. Here, moreover, we miss that cellular or connective tissue which lines all the interstices of the different organs in the Vertebrata; and in consequence of its absence we meet with large, empty, free spaces or lacunæ, which separate the organs. The lymph and the chyle not being enclosed in vessels fall into these spaces, which are thus filled by the liquid which is being elaborated to repair the losses of the blood. We may easily comprehend from these few words how important a physiological part must be played in the Invertebrata by the general cavity which results from the presence of these lacunæ, and by the fluid enclosed within that cavity.

We have already observed that in the Vertebrata the chyle and the lymph are poured directly into the vascular apparatus of the blood by means of the vessels which enclose them. In the Invertebrata, where these vessels are wanting, this cannot occur; and here two cases may present themselves. When

the circulatory circle is *incomplete*, and when there exists some sort of interval between the termination of the arteries and the origin of the veins, the blood itself falls into the general cavity of the body, and its admixture is effected within that cavity. Such is the case in Insects, Crustaceans, Molluscs, &c.

When the circulatory circle is *complete*, when the arteries and veins form a continuous circle, the reparatory matters of the chyle and of the lymph can only reach the blood by traversing the walls of the blood-vessels. Certain of the Radiata and all the Worms exhibit this phenomenon.

But whatever may be the existing anatomical dispositions, there is one fact which we observe in all animals. In order to become adapted for the nourishment of the animal and to be transformed into blood, chyle, and lymph, all the materials destined to repair the incessant losses depending on the wear and tear of the organism must first be exposed to the action of the air. Thus in the Vertebrata the lymphatic vessels open into the veins, in the immediate vicinity of the respiratory organs. In the Invertebrata even, when the blood mixes directly with the chyle and the lymph, the anatomical dispositions bring about a precisely similar result.

When the blood on the one hand and the chyle and the lymph on the other, are enclosed in distinct cavities without communicating with one another, it becomes necessary that these two latter fluids should each undergo a special respiratory action. Innumerable observations proved to me long ago that such was the case. In the Worms more particularly, the

liquid of the general cavity is subjected to the respiratory action, quite as much as the blood itself.*

Hitherto I had constantly seen the skin alone performing this function. The air exerted its action on the liquid to which I refer solely by means of the integuments, either of the whole body or of some portion of it which moreover served other purposes. No animal was known which possessed special organs for subjecting the chyle and the lymph to the respiratory action; and consequently the observations which I made on the Branchellion afforded me ample materials for thought.

The lateral appendages of this animal are not perfectly similar, some are thin and laminated throughout their whole extent, others, to the number of about two and twenty, are regularly partitioned and arranged in pairs, having at their base a hemispherical and semi-transparent enlargement. In each of these protuberances (*mamelons*) I discovered a kind of sac (*ampulla*), which regularly dilated and contracted in the same manner as a heart. Such is in effect the nature of this organ, and the liquid which it encloses is the blood of the animal. This blood appeared, however, in healthy individuals, to be tinged with a fine brownish-red colour, whilst the liquid circulating in the appendages themselves ap-

* These facts and the consequences deducible from them, have met with considerable opposition. I have, however, daily the pleasure of finding that they are more and more thoroughly confirmed, and often in the most conclusive manner, by observers who believe that they are making new discoveries while they are only repeating my observations.

peared perfectly colourless. These two liquids could not therefore be of the same nature. If one were the blood properly so called the other could be nothing but the liquid of the general cavity.

Such was the conclusion which I deduced from observation alone, but which was fully confirmed by experiment. On injecting the vessels, I filled all the sacs without reaching the appendages, and I found that, in order to penetrate into the latter, it was necessary to pass the instrument into the lacunæ, that is to say, into one of the dependencies of the general cavity, and I then obtained the result of which I have already spoken. Thus the lateral appendages of the Branchellion were not only branchiæ but they were moreover *lymphatic* branchiæ.

In making this injection, the fluid did not enter the appendages alone, for the coloured liquid reached the intestine and presented on its surface a network of large meshes. Besides this, it had filled a special vessel placed on either side below the skin, and communicating with all the branchiæ. Lacunary passages connected these two cavities together, and the whole of these canals, lacunæ, and well-characterised vessels, which were everywhere filled with a mixture of chyle and lymph, represented, as we have seen, the general cavity of the other Invertebrata. There was only one portion of its dependencies consisting of vessels properly so called which formed a true rudimentary lymphatic apparatus.

This was at once a totally novel fact in the history of the Invertebrata, and a new proof that nature everywhere remains faithful to the great law of the pro-

gressive perfection of organisms. Like the apparatus of the circulation for the blood, of which we have already spoken, the apparatus for the lymphatic circulation first shows itself to be very incomplete; and, if we were to follow it in its transformations, we should find that it was not completely isolated, nor definitely constituted as such, until after we have passed through the lowest group of the sub-kingdom of the Vertebrata, namely, the class of Fishes.

Thus, by the presence of lateral appendages, the Branchellion deviates from all the Hirudineæ, while by the respiratory action of these appendages, it differs not only from the group in which it has been placed, but also from all the neighbouring groups. Finally, the identification of these respiratory organs as lymphatic branchiæ completes the thoroughly exceptional character of the animal.

If indeed the principle of dominant characters were as true as Cuvier supposed it to be, and as some anatomists still assert; if the slightest modification in an apparatus destined for the accomplishment of one important function really exercises over all the rest of the organism the influence that is attributed to it; an anatomical examination of the digestive, vascular and nervous systems ought to exhibit dispositions not less novel. Such, however, do not exist in this instance.

There can be no doubt that there are differences between the Branchellion and ordinary leeches, but these differences are not of a very important kind. The greater number of them do not exceed in importance those which we meet with among the most

nearly allied genera of this group. Although it is abnormal in regard to the lymphatic respiration, the Branchellion in all other respects is merely an ordinary leech. Classification, which is not science, but which ought as far as possible to be the expression of it, has here a double fact to record, and it will consequently be necessary again to deviate from some of those rules which have been deduced from too exclusive a study of the higher animals.

By introducing into zoology the great principle of the subordination of characters discovered by Laurent de Jussieu*, Cuvier rendered an immense service to science. From that moment the value and not the number of characters determined the division of the animal kingdom, like that of the vegetable kingdom, into naturally sub-divided groups. But in arriving at the appreciation of this value the two men of genius whose names we have quoted proceeded in a very different manner, for while Jussieu consulted only the evidences of observation and experimental research, Cuvier, as he himself declares, attached a pre-eminent and almost exclusive value to reasoning.† He judged of the importance of the organs by the importance of the functions, and then proceeded to the characters yielded by those organs.

Nothing can be more apparently rational and logical than this, but unfortunately nature often seems to take a malicious pleasure in sporting with our

* [A sketch of the scientific services of the different members of the family of De Jussieu is given in the Appendix, Note III.]

† *Règne animal*, 2e édition, Introduction.

reason. That magnificent *à priori* mode of conclusion, which may be true as long as it is limited to the Vertebrata, becomes in many cases strikingly inexact when it is extended to the Invertebrata, and more especially to the most degraded representatives of this great sub-kingdom. To those who would adopt literally, in the strict sense of the word, all that Cuvier has stated in respect to respiration and the respiratory organs, the Branchellion would in itself form a distinct class.* To a follower of Jussieu it would be merely the type of a sub-class, and this is the point of view which we ourselves incline to adopt. The nomenclature will thus express, if we substitute value for number of characters, the resemblances which connect the Branchellion with the other Hirudineæ and the differences which distinguish it from them.

At the risk of appearing somewhat too technical, I have thought it necessary to present my readers with the preceding anatomical and physiological details. I have deemed it necessary to show at some length how the minute examination of a single animal, if the selection be a good one, leads us to the most varied and delicate questions of zoology. I

* I ought, however, to observe that Cuvier himself was always most anxious to avoid this strict interpretation of his views. In this great man pretensions to infallibility and a systematising spirit never took the place of the most perfect good faith, and that sound common sense which is one of the attributes of true genius. Thus, more especially in the classification of the Annelids, he has not hesitated to give way to facts in preference to the rules which he had himself established, and this is certainly in a great measure owing to the circumstance that he never confounded classification and method.

have been anxious to afford to those who have followed me thus far some idea of the nature of that general revision of accepted facts which is required in the present state of science; and, if my explanations have been in any way successful, my readers will readily comprehend the pleasure that I experienced from my study of the Branchellion, and the satisfaction that I derived from the results of my labours.

CHAP. X.

THE COASTS OF SAINTONGE.

CHATELAILLON ; ESNANDES.

The evident marks of great changes in the coasts of Saintonge; encroachment of the sea; destruction of Montmeillan, and of Chatelaillon; accumulations due to marine action; salt marshes. — The former gulf of Poitou; elevation of Saint-Michel-en-l'Herm; Esnandes.— Walton the Irishman; his introduction of a new breed of sheep; his nets; the *acon* and *bouchot*; Mussel-beds.— Excursions to Esnandes; shrimp-fishing.—The Termites; ancient fables regarding them; habits of the Termes bellicosus; the buildings erected by these insects; fecundity of the queen; the ravages occasioned by them. — French Termites; their recent appearance in Europe; the Rochelle Termites; the destruction they have effected in the Prefecture of that city.—Observations made on Termites in confinement; means of destroying these insects.

THE coasts of Saintonge and the neighbouring districts have not always presented the form and outlines which they now exhibit. Few coasts perhaps have experienced more marked changes since the great geological revolution which gave them origin. It is true that elsewhere at the mouth of large rivers new lands are often formed, and without going beyond France we find that the Rhone presents us with an example of one of these deltas at La Camargue, while, moreover, there are many other points which the sea is incessantly wearing away as it extends its barriers farther and farther inland. French

Biscay presents us with a curious example of these erosions, but in cases analogous to those to which we have referred the modifying action of rivers or of the ocean is always exerted in one and the same direction, whether in the creation or the destruction of deposits. In Saintonge, owing to the structure of the continent and the mineralogical nature of the soil, these two effects are being simultaneously produced. Everywhere the ocean attacks and demolishes piece by piece the salient points of the coast, everywhere it fills up the receding portions; and the final results of this double action will be to fill up gulfs no less than to wear away advancing promontories. Sooner or later the coast line to the north of La Gironde, from Point la Coubre as far as Longueville, which was formerly so deeply indented, will be almost as uniform as that which extends southward from the Point de Grave as far as Saint-Jean-de-Luz; or at most a few slight curves, formed by the alternation of flat beaches and headlands, will be all that remains to our descendants of the deeply indented bays, the advanced capes and peninsulas, of former days.

Whether in respect to ancient or to modern times, the formation of new land is confirmed both by direct observation and by historical evidence, but tradition has almost always been the only authority in reference to the encroachments of the sea, and this species of proof is often of a very inconclusive kind. The formation, since the Roman epoch, of the bay of Mount Saint Michael, the separation, not earlier than the middle ages, of the island of Sésambre, which is now

situated at not more than six miles from Saint-Malo, are probable rather than certain facts, but in Saintonge one cannot entertain any doubt in regard to the erosive power of the waves. Here important towns have crumbled with the cliffs that overhung them, and the ocean, after having reduced their ruins into dust, is every day carrying away some fragments from the districts surrounding them. History has preserved to us the names and annals of these towns; and, guided by the light which she furnishes, we may readily trace the sinuosities of the ancient shore by the inequalities of the bottom of the ocean, as it is laid down on the charts of M. Beautemps-Beaupré.

About nine miles to the south of La Rochelle lies the point of Chatelaillon, which is separated from the island of Aix by an arm of the sea which is about 6000 or 7000 yards across. In the middle ages a high road passed from the one to the other on which were situated two towns. The existence of Montmeillan is only known to us by an authentic *procès-verbal* recorded by one of the old annalists of La Rochelle.* It is different, however, with Chatelaillon, which

* Amos Barbot, quoted by Arcère, who has frequently referred to his manuscript. The following is an extract from this *procès-verbal*: "The town of Montmeillan was situated between Chatelaillon and the Isle of Aix, to which said city and island one might walk on land and dry-footed at low tide, according to the statements of old people who have themselves made this journey." This *procès-verbal* bears the date of 1430, and from these statements we are led to conclude that within a hundred years before that epoch, that is to say, in the course of the fourteenth century, a communication existed between the island and the continent.

was for a long time the principal city of the ancient Aunis, and whose authority extended even over La Rochelle. Founded, according to tradition, by Julius Cæsar, and fortified, as Arcère asserts, by Charlemagne, it became, even before the twelfth century, a considerable barony and occasionally bore the title of a principality. The Isamberts, its first lords, were frequently allied in marriage with the families of the reigning sovereigns. It was often at war with the powerful counts of Poitou and the dukes of Aquitaine. At a later period Chatelaillon numbered amongst its rulers the Richemonts and Dunois. It was then a fortified town surrounded by high walls and deep fosses. At its base lay a vast harbour, and every ship which entered its waters was compelled, under penalty of heavy reprisals, to lower her flag. Not a trace now remains of these walls and fosses, which have all been engulfed in the sea. In 1660 seven towers which formerly commanded the neighbouring country still commanded the bay, but the storms of one winter carried away the last remains of these fortifications. At the beginning of the present century, during the wars of the empire, a fort was erected upon the Point, but this too has been thrown down. At the present day a humble Custom-house depôt has succeeded these fortresses of past ages, but it has not been erected upon their remains, for on these ever-crumbling heights, towers and bastions have scarcely time to leave a trace, so rapidly are they undermined by the power of the waves.

MM. Viviers and Beltrémieux, two men who combine an ardent love of science with the absorbing

duties of a professional life, accompanied me, on a fine day in September, to this ever-receding shore. My companions had each provided themselves with a bag and a geologist's hammer; and, with a lingering hope of finding some zoological treasures, I took with me a few bottles and glasses in addition to my pick-axe which might perhaps serve a double purpose. At Angoulin, we reached the beach, which is covered at this point with enormous blocks of stone formed either entirely of polyparies or of the remains of shells and of fossil sea-urchins. Elsewhere such a locality would have furnished me with ample materials, but here a bed of soft mud flowed onward to within a couple of feet of the rocks at the high-water mark, and, finding that it was hopeless to look for living animals under such circumstances, I imitated my companions, and applied my pickaxe to this mine of fossils which was opened before us.

At Chatelaillon the prospect was equally bad, but in this case I was not disappointed, and, without losing time in the vain search for animals in this unfavourable locality, I directed my undivided attention to the curious spectacle presented by the adjoining coast. Above us rose the cliffs, which were then in shade and looked like an immense perpendicular wall veined with broad and almost horizontal bands. Here and there immense masses, which seemed ready to fall, projected like turrets from the rest of the surface; numerous blocks that had been recently fractured were to be seen in all directions, and seemed to warn us that this crumbling away of the rock might recur at any moment, and that no unnecessary

time should be lost in collecting our fossils. To the north, the island of Ré and the Point Chef-de-Baie appeared almost to meet; whilst to the west, facing us, the strait of Antioche opened a broad vista towards the Atlantic which here is known by the name of the *mer sauvage*; to the south, the Point of Fouras and the Isle of Oléron almost entirely blocked up the strait of Maumusson. In the midst of this basin rose, like some watchful sentinel, the Isle of Aix, whose bastions and cliffs were gleaming brightly in the sunlight. Between this island and the spot on which we were standing there spread to a distance of nearly three miles, and almost at the water's level, the plateau of Chatelaillon, which was at this moment enlivened by the presence of several hundred fishermen, who had been busy in catching Mussels, and who, loaded with their booty, were hastening with rapid strides before the rising tide. The waters were rising quickly up this slightly inclined slope, and we were soon able to judge of their progress by the agitation of the mud. Here land and water are so much alike in respect to colour and consistence that the eye can scarcely distinguish them by any other indications excepting those afforded by motion. In proportion as the tide rose we saw the plain covered with undulations and long parallel furrows, the whole looking like some vast field of clay that is being broken up by an invisible plough. A tempest on this beach must present a very singular appearance, for it must seem as if the cliffs were being besieged by moving lines of rocks, and not merely by waves.

The mud which covers the plateau of Chatelaillon does not, as we may readily suppose, entirely supplant those districts on which formerly rose the towns and fortresses of the Isamberts. Driven back by the currents, these *débris* have been carried along the whole length of the coast, and have been arrested within every sheltered creek and every calm basin. Thus have been formed the low and marshy lands of Brouage, and of the basin of the Charente, near Rochefort, and the alluvial deposits lying at the foot of the bay of Fouras, at Ché, and all round La Rochelle. These alluvial beds, which are only slightly elevated above the level of high tide, are admirably adapted for the fabrication of salt, and indeed all these bays run inland in the form of salt marshes. The sea-water is carried by sluices and canals far inland, and flows back to the ocean with the ebbing tide, and this branch of commerce is thus extended to the very limits of the newly accumulated deposits of soil.

The salt marshes of Saintonge are well worth the attention of the traveller. Having been established in a district which is not so warm as those parts of Southern France in which the other salt works are situated, they have here been arranged in such a manner as to compensate for a deficient intensity in the sun's rays. For this purpose the extent of surface has been greatly multiplied, whilst the arrangement of the tanks in which the water is collected for evaporation is much more complicated than at Gard or Hérault. Here each marsh is composed of seven distinct kinds of compartments, which are arranged

at different levels, so that the liquid may easily pass onwards from the first to the last in the series.

The marsh is a large square, enclosing on the side nearest the water the first basin or tank, which is about one yard deep, and called the *jard*, in which the sea-water is allowed to deposit its sediment by remaining at rest before it enters the *conches*, in which begins the work of evaporation. These *conches* are three very narrow basins, from six to eight inches deep, and arranged in such a manner that on passing from one to the other the water is obliged to traverse the whole width of the marsh in a zig-zag direction. The *mors* and the *tables*, in which the sea-water is subjected to a second and third evaporation, are of very nearly the same dimensions and surround an oblong space occupying about the third of the marsh. This enclosure is divided into two parts by a broad basin, about two inches in depth, called the *muant*. To the right and left of the latter are arranged the compartments known as the *nourrices*, which are only an inch deep. Here the solution, which has become more and more concentrated by its sojourn in the preceding compartments, undergoes its fourth and last preparation before it enters the enclosures in which it is suffered to crystallise. Small elevations of clay are arranged with the most perfect regularity around the different compartments, which they sufficiently isolate from one another, and thus serve all the purposes aimed at by this mode of arrangement. The whole lies upon the blue or yellow argillaceous earth *, which is entirely

* It has been remarked that the nature of the soil influences the

composed of the alluvial deposits that have been left by the sea.

To comprehend the whole extent of these accumulations of soil, one ought to proceed about six miles north of La Rochelle to the bay of Aiguillon. In our own time this bay forms a nearly regular crescent, whose entrance is scarcely more than 7000 yards across, while its depth is 9000 yards. Formerly the sea entered the land from Longueville to the Point Saint Clement by an opening of more than 34,000 yards. The gulf then widened, and gave off deep and indented secondary bays in all directions, to the north as far as Luçon and Maillezais, to the east as far as Niort and Grip, and to the south as far as Benon and Aigrefeuille. From the entrance of the gulf to Niort, the distance was not more than fifty kilometres *, while it was forty-two kilometres from Luçon to Aigrefeuille. To go in a straight line from Luçon to Aigrefeuille it was necessary to cross the gulf from north to south, passing over about forty-two kilometres of water, while at the present day this journey may be made entirely by land. Longueville is now about twenty-five kilometres from the shore, Luçon more than twelve, Maillezais about twenty-nine, Niort forty-eight, Grip forty-nine, Benon twenty-one, and Aigrefeuille about twenty-two. Between the southern extremity of the bay of Aigrefeuille, and the ancient basin of Fouras, the

quality of the salt. The blue clay is the only one which yields a very white salt, whilst the product of the yellow clay, is always coloured with the same hue.

* [The kilometre is 1093 yards.]

distance was only six kilometres, nor was it farther between this bay and the northern branch of the basin of the Charente. We see that the ancient barony of Chatelaillon, comprising the territories of La Rochelle and Esnandes, formed a true peninsula, presenting to the sea a straight line of coast measuring about thirty kilometres, and connected with the continent by a very narrow isthmus.

The changes that I have indicated may be seen at a glance on the magnificent atlas of MM. Dufrénoy and Elie de Beaumont, for we can here trace the ancient coast lines by observing how far the alluvial deposits have penetrated inland. It must not, however, be supposed that these changes have been effected by one of the great revolutions of which our globe still bears those traces which science alone can interpret. These results were brought about at a period which, comparatively speaking, is quite recent, and here geology has done no more than confirm the indications of history.

Ptolemy, who knew and named the Charente, does not speak of the Sèvre, and we may easily comprehend the reason of his silence, for at the period at which the celebrated geographer wrote, the Sèvre was a very inconsiderable stream which entered the sea at Niort. In proportion as the gulf has been filled up the stream has been lengthened and widened, and acquired new affluents, until it now merits the name of a river. Its embouchure has successively advanced behind many islands which had previously been placed far in front of it, and which, being enclosed by the surrounding land, form in the present

day so many hills, which are scattered over the plain in the same manner as they formerly appeared upon the sea.* Maillezais, Marans, Velluire, Triaise, Maillé, Vildoux, and a dozen other villages or hamlets were surrounded by water even at as late a date as the thirteenth century. We still meet at certain points with posts having iron rings attached to them, which formerly served to fasten boats and ships. This movement has not diminished in our own times. When Father Arcère wrote, a little less than a century ago, there lay to the north of the bay an island formed of steep rocks and known under the name of La Dive. The annalist of La Rochelle remarks that the Point of Aiguillon was advancing each year, and that in a little while the lowlands would reach these rocks. Fact has very speedily confirmed these predictions. In 1824, La Dive was in the midst of fields, and the Point inclining southward was about four kilometres in advance of it.

From the facts and dates to which we have here referred, it would seem that the gulf of Poitou remained till towards the beginning of the middle ages very nearly in the same condition in which it had been left by the last cataclysms; that is to say, it remained open to the waves of the ocean for several thousand years, and that, dating from some undetermined although probably entirely modern epoch, it began rapidly to be filled up. If this

* From Rochefort the Charente has increased in the same manner. From this point, as far as the sea, there extends a gulf, one of whose arms, as I have already remarked, is directed northwards, and nearly joins the bay of Aigrefeuille.

were really the case, this accumulation of soil may not be the sole cause of the actual progress of the continent. It is probable that we must associate this fact with a totally different order of phenomena, of which Scandinavia furnishes a remarkable example.

It is well known that the coasts of this peninsula are rising on the one side by a movement which is so regular and slow that it admits of being measured.*

* According to an ancient tradition, the Scandinavian peninsula was formerly an island, and this opinion seems to be confirmed by numerous facts. Several towns which were originally built on the borders of the sea are now more or less distant from the coast. We may explain this phenomenon, as in the case of Aigues-Mortes, by the deposition of soil. Rocks mentioned by ancient bards, and which have maintained their old names, served formerly as a place to which Seals resorted, although at the present day these ledges lie far too high above the level of the sea to allow of their being reached by those animals. These facts, and several others which have been long known, had led to the opinion that the level of the Baltic was gradually sinking — a view which was advocated by Celsius, Bergman, and Linnæus. In 1820 the Russian and Swedish governments appointed a scientific commission to examine this question, which was at once curious in a scientific point of view and very important in respect to all littoral districts. This commission ascertained, indeed, that the level was gradually declining at certain points, but they discovered at the same time that the fall was not everywhere uniform, and that at some points it was absolutely null. The opinion that had long prevailed among the simple fishermen was then finally adopted, namely, that the sea kept its level but that the land was rising.

Some of the most eminent of our geologists, amongst others Leopold von Buch and Sir Charles Lyell, made a voyage expressly to test the accuracy of these conclusions, and they confirmed the results, which have been still further verified by MM. Bravais and Martins. From these researches it would appear that the shores of the Gulf of Bothnia are slowly rising, and that this rise is about

Does anything analogous to this occur in this gulf, and is its gradual filling up even partially owing to a progressive elevation of the district above its ancient level? This question is so much the more admissible, as positive facts attest at several points the recent action of those geological forces which are incessantly modifying the thin pellicle which we call *terra firma.* In the environs of Fontenay, in the very midst of the marshes whose origin we have described, exist deposits of shells well known to geologists under the name of the banks of Saint-Michel-en-l'Herm. These extensive banks are composed of the shells of oysters, mussels, and pectens, belonging to the same species that occupy the neighbouring seas.* All these shells are apparently retained in their original position; a great many of them have their valves connected by the ligament which completes the hinge, and they have not

four feet during every century at those points at which it is the most rapid.

On the other hand, it would appear from marks made upon the coast of Scania in the time of Linnæus, that this part of the shore is gradually sinking below the water. The same phenomenon is manifested on the coast of Greenland, over an extent of more than 600 miles. Buildings placed upon low islands, or upon the continent, have been submerged, while it has been found necessary at different times to remove farther inland the establishments erected on the beach. It is therefore probable that on these regions the earth's crust presents at the present day one of those movements giving rise to the flexure of strata, which modern geologists appear to agree in regarding as an important feature in geological phenomena.

* The three banks of Saint-Michel-en-l'Herm are about 730 yards in length and 300 yards in width, rising from ten to fifteen yards above the level of the surrounding marshes.

even changed in colour, while some of them still enclose a yellowish animal matter, the remains of the Molluscs which formerly occupied them. Everything in these banks indicates that the inhabitants of these shells lived and died in the spot where their remains are found at the present day, and yet their upper beds are from nine to fourteen yards above the level of the highest tides. To explain their existence we must, therefore, admit the occurrence of circumscribed local upheavals. With these facts before us, there seems no difficulty in assuming the occurrence of a slower upheaval extending over all the neighbouring districts.

Be the causes, however, what they may, it is certain that the entrance at Point Aiguillon is incessantly contracting towards the north. On the southern side, the coast has not undergone any notable change, and Point Saint Clement still shelters, as it did in the middle ages, the little village of Esnandes. Hither I was conducted by Doctor Sauvé, in order that I might observe the curious phenomena which are an exact counterpart to those that may be seen at Chatelaillon. An hour's rapid drive sufficed to carry us over the undulating hills of the primitive isthmus, and from the brow o the last ascent we could perceive at our feet Esnandes, with its pretty white and clean-looking houses and its singular church. This last edifice in no respect resembles a peaceful house of prayer. If it were not for the cross which surmounts the massive square donjon-like tower, one would be disposed to take it for a fortress. Ruined fosses still surround

it, and the roof is concealed by a platform which entirely encircles it, and is flanked with turrets and bristles with battlements. The gate and all the windows are commanded by loopholes, while numerous embrasures complete the preparations of defence. By way of greater security, every opening looking towards the sea has been carefully blocked up. This was indeed the point from which danger was to be apprehended; for, protected by its marshes, Esnandes had nothing to fear excepting from the incursions of pirates, and being too poor to enclose herself within walls, she had metamorphosed her church into a fortress. Marsilly and several other villages on the coast trusted to similar means of defence, but none of these fortified churches have been so well preserved as the one of which I have spoken.

From the tower of Esnandes the eye embraces the whole of the neighbouring country. To the south the view is bordered by the hills, which extend as far as La Rochelle, and by the small plateau of Vildoux, whose ancient shores still retain the iron rings to which the ships of the middle ages were moored. To the north and east extends, like one great solid lake, the plain, which is enamelled with the rich tints of the flowering meadows, the waving cornfields, and the glistening marshes. On the horizon rise the cathedral of Luçon, and the hills of Maillezais and Fontenay, whilst Marans and its neighbouring district, resuming for a moment the appearance of what they once were, resemble a small island. To the west the shore merges so in-

sensibly into the sea that all limits seem to disappear, and the eye passes almost imperceptibly from the land to the ocean. Between the two there intervenes, however, a belt of mud, which, incessantly driven inland, becomes accumulated, and extending to the highest limit of the tides, dries, and, becoming consolidated, is soon covered with littoral plants, after which it can no longer be carried away by the force of the waves. It thus gradually advances day by day, and threatens rapidly to fill up all that yet remains of the ancient gulf. A seafaring man who together with the beadle did the honours of the church to us, gave us a convincing proof of the rapidity of this invasion of the coast. At our feet lay a jetty which had been constructed in this man's youth. It then marked the limits of the shore, and its sides were beaten by the waves at every high tide. In the present day, it stands in the midst of fields, and is used as a cross-road, while between it and the sea there extends a zone of two kilometres in width and eight kilometres in length. The bay has thus lost all this space at this one point within half a lifetime.

Situated on the borders of a kind of mud lake, Esnandes has become the centre of a curious branch of industry, which has spread to the villages of Charron and Marsilly, but which is not to be met with at any other part of the coast. We refer to the breeding of mussels, which is as great a source of general competency to the inhabitants of the bay of Aiguillon as are the oyster-beds to the fishing population of all our coasts, more especially at Ma-

rennes, Cancale, and Saint-Vaast. The origin and development of the mussel trade, which are attested both by tradition and ancient records, have been ably discussed by M. d'Orbigny, in a pamphlet which is very little known in consequence of its having been published in a small provincial town. It is from this work that we have borrowed the following details.*

In the year 1035 an Irish bark loaded with sheep was thrown in a heavy storm on the rocks near Esnandes, whose sailors hastening to the scene of the catastrophe were unable to save any one on board excepting the captain. This man, whose name was Walton, amply repaid the services which had been rendered him; for having saved some of the sheep from the wreck he crossed them with the animals of the country, and thus produced a fine race, which is still held in high estimation, and is known under the name of the marsh sheep. He next devised a kind of net, the *allouret*, which was stretched a little above the level of the open sea, where it caught entire flocks of those shore birds which skim the surface of the water at twilight or after dark. In order to render these nets thoroughly effective, it was necessary to go to the very centre of the immense bed of mud, where these birds seek their nourishment, and to secure a sufficient number of poles to support the nets, which were between three and four hundred yards in length. Walton also invented the *pousse-pied* or *acon*, a kind of boat which is still in use.

* *Histoire des parcs ou bouchots à moules des côtes de l'arrondissement de La Rochelle*, by M. C.-M.-D. d'Orbigny père. La Rochelle, 1847.

The *acon* is composed of a plank of hard wood, which constitutes the bottom, and is called the *sole*. This plank is bent in the fore part in such a manner as to form a sort of flat prow. Three light planks, which are nailed together at the sides and back, complete this simple boat, which is not more than two or three yards in length and from twenty to twenty-five inches in breadth. A short pole and a wooden paddle constitute the whole of its equipment. In using the *acon*, the boatman rests on one knee, while he passes the other leg over the side of the boat, where, provided with a long boot, it serves the double purpose of an oar and a rudder. The boatman, who is balanced on the *sole* of the *acon*, whose sides he firmly grasps, plunges his foot into the mud until he reaches a comparatively firmer part, when he propels the boat onward. The *acon* is thus made to glide over the fluid mud, and by means of this fatiguing process the Esnandes boatmen sometimes move with such rapidity, that I have often found it difficult to keep up with them, although I was walking at a quick pace along the beach.

The mode of locomotion which we have just described requires a soft and smooth soil. It happens, however, that every year, in consequence of the heavy storms of winter, the bay undergoes a remarkable transformation throughout its whole extent. The mud appears to be moulded by the waves, whose form it retains. From north to south there extend, parallel to the shore, long furrows at equal distances from one another, which are sometimes more than a yard in height. During high tide the crests of these

furrows dry and harden in the heat of the sun. At such times the *acon* cannot be used, and to enable these boats to be worked easily, it would be necessary to level every part of this vast basin, which extends over a space of more than 75,000,000 of square yards. Such a labour as this, if human industry were to attempt it, would obviously be found to be impracticable, even if the whole population of the district were to devote the entire summer to the task. Yet this herculean labour is accomplished in less than a month through the agency of a Crustacean, whose body, which is scarcely thicker than a piece of sewing cotton, is not more than half an inch in length including the antennæ.

Towards the end of April the little Crustaceans, termed by the fishermen the *Pernis* (*Corophium longicorne*), arrive from the open sea in myriads. Guided by their instinct, they come to wage an exterminating war against the Annelids, which during the whole winter and early spring have multiplied undisturbed. As the tide rises, these voracious hordes are seen moving about in all directions beating the mud with their long antennæ, and pursuing Nereides and the Arenicolæ to their deepest recesses. When once they discover one of these animals, which are several hundred times larger than themselves, they combine to attack and devour it, and then resume their eager chase. This carnage never ceases till the Annelids have almost entirely disappeared, but by that time the entire bay has been dug up and levelled, and the *acons* are again able to move readily over its surface. Before the close of May the work is completed, and

then the Corophium turns upon the molluscs and fishes, which it attacks whether living or dead. Through the whole of the summer these Crustaceans remain upon the coast, but towards the end of October they all disappear in one night, ready to return the following year and resume their useful labours of digging and delving.*

Walton discovered on examining the poles which supported his nets that they were covered with mussel spawn, and that the Molluscs which were thus produced in the open sea, and beyond the immediate contact with the mud, were finer both as to size and quality than those which were bred nearer the shore. He then increased the number of his poles, and after various attempts, constructed his first artificial mussel-bed or *bouchot*. At the level of the lowest tides, he drove into the mud stakes that were strong enough to resist the force of the waves, and placed them in two rows about a yard distant from one another. This double line of poles formed an angle, whose base was directed towards the shore and whose apex pointed to the open sea. This palissade was roughly fenced in with long branches, and a narrow opening having been left at the extremity of the angle, wicker-work cases were arranged in such a manner as to stop any fishes that were being carried back by the retreating tide. Walton had thus combined in one a sort of fish-preserve with a bed for the breeding of mussels. The merits of this invention must have been at once appreciated, for it

* *Mémoire sur la Corophie longicorne*, by M. d'Orbigny, *Journal de Physique*, 1821.

soon became very popular, and the *bouchots* were extended in several directions. It was soon found inexpedient to trust only to the chance of the currents and waves that might bring in the young mussels, to the poles and fences, and men frequently went to a very great distance, even as far as the plateau of Chatelaillon, in search of the young Molluscs. At the same time this branch of industry was constantly undergoing improvements, becoming as it were more and more systematised, whilst its various operations were designated by names, which, having been borrowed from a totally different order of ideas, might lead a stranger, who heard the conversation of two *boucholeurs*, to suppose that they were discoursing on agricultural matters.

The little mussels that appear in the spring are known as the *seeds*. They are scarcely larger than lentils till towards the end of May, but at this time they rapidly increase, and in July they attain the size of a haricot bean. They then take the name of *renouvelains*, and are fit for transplanting. For this purpose they are detached from those *bouchots* which are situated at the lowest tide mark, and are then introduced into pockets or bags made of old nets, which are placed upon the fences that are not quite so far advanced into the sea. The young mussels spread themselves all round the pockets, fixing themselves by means of those filaments which naturalists designate by the name of the *byssus*. In proportion as they grow and become crowded together within the pockets, they are cleared out and distributed over other poles lying somewhat nearer to the shore,

whilst the full grown mussels which are fit for sale, are planted on the *bouchots* nearest the shore. It is from this part of the mussel-bed that the fishermen reap their harvest, and every day enormous quantities of freshly gathered mussels are transported in carts, or on the backs of horses, to La Rochelle and other places, from whence they are sent as far as Tours, Limoges, and Bordeaux. They will no doubt soon be sent to Paris, by means of railways, and our epicures may then compare the wild mussels, which are sent to us from Normandy and Boulogne, with those that have been artificially bred by Walton's system.

The following data, which were collected by M. d'Orbigny more than twenty years ago, will show how important this branch of industry must be to the district in which it is cultivated. In 1834 the three communes of Esnandes, Charron, and Marsilly, representing a population of 3000 souls, possessed 340 *bouchots*, the original cost of which was valued by M. d'Orbigny at 696,660 francs; the annual expenses of maintaining them amounted to 386,240 francs, including the interest of the capital employed and the cost of labour, which however is spared to the proprietor who works on his own account. The nett revenue is estimated at 364 francs for each *bouchot*, or 123,760 francs for the three communes. Finally, the expense of the carts, horses, and boats, employed in transporting the mussels, then amounted annually to 510,000 francs; but these numbers are far from representing the expenses or profits at the present day. At the time that M. d'Orbigny lived at Es-

nandes, the *bouchots* were only arranged in four rows; now, however, there are no less than seven rows, and some of them measure more than one thousand yards from the base to the summit. The whole of these *bouchots*, which were at first limited to the immediate neighbourhood of the three villages of which I have already spoken, extend at the present day uninterruptedly from Marsilly far beyond Charron, and form a gigantic stockade of two miles and a half in breadth and six miles in length.

Unfortunately, however, the enormous extension of these *bouchots* has given rise to some inconvenience. In former times, if a ship were driving before the wind, it could generally find a safe refuge on this bed of soft mud, where there was very little danger to be apprehended even in case of running aground. As long as the *bouchots* were constructed of simple poles, a merchant vessel, or even a fishing boat, could easily strike them down; and at worst, they would only experience some slight damage in crossing the palissades; but in proportion as the *bouchots* have been extended further out to sea, and have been brought into the deeper portions of the bay, it has been found necessary to increase their solidity, in order to prevent their being torn up or broken by the waves, and the simple poles of Walton have been changed into strong and thick piles. At the present day ships are obliged in a storm to wait outside the *bouchots* until the full tide enables them to pass above these palissades. Were they to neglect this precaution, they would run the risk of being driven upon stakes as thick as the trunk of a tree, which would be as dan-

gerous to a ship as to run upon a rock. We can scarcely therefore wonder that the sailors and fishermen should make numerous complaints against these *bouchots*. The *boucholeurs* on their side deny or extenuate the facts of the case, and it is said that the courts of justice, when called upon to decide between these opposite parties, are often at a loss how to award their verdicts.

After having seen the spot and examined these *bouchots*, we are of opinion that it would be a very easy matter to arrive at an equitable decision. It would of course be alike absurd and cruel, either directly or indirectly, to destroy the *bouchots*, and thus at one blow to deprive a whole district of a flourishing branch of commerce which has existed for more than eight centuries. On the other hand, the *boucholeurs* cannot be suffered to take possession of the whole shore, and to transform the only harbour of refuge along this line of coast into a bay studded with gigantic spikes. But if an opening were made through these palisades all interests might be maintained and respected. A channel of 400 or 500 yards in width, would be more than sufficient for the purpose. At the cost of a small indemnity, which would be justly due to the *boucholeurs*, whose property had been interfered with, the communication between the entrance and the foot of the bay would be re-established, whilst the various *bouchots* that still remained would serve in the place of breakwaters.

I have twice visited Esnandes. On one occasion I accompanied M. Sauvé on an excursion in an *acon*,

and I then made my way, as far as the first *bouchots*, across this enormous lake of mud, which has been rendered productive and navigable by the ingenious contrivances of Walton. In this excursion, I had the pleasure of conversing for a few moments with a descendant of the Irish captain. This man, who was a simple *boucholeur*, and in no way to be distinguished from his fellow-labourers, was as proud of his name as if he had been a Montmorency, and who could blame him for this pride? His name recalls the services rendered for eight centuries to an entire population, which owe to them their occupation and their competency. Surely such a title of nobility may bear comparison with that of many of our proudest houses.

Some time afterwards, I again visited the *bouchots*, and passed beyond their lines in company with M. Valenciennes, who had been commissioned by the Minister of Marine to examine the coast fisheries, in order to decide upon the spot many important questions connected with their management and regulations. A journey of this kind with a *confrère* who is justly regarded as the first ichthyologist of our day was a source of the greatest enjoyment to me.

Having left La Rochelle in the evening, it was already late at night when we reached Esnandes, where, from want of accommodation at the only inn of the village, we were obliged to accept the hospitality of the Syndic. This worthy man who, like the rest of the population, had led a seafaring life, did the honours of his house in a truly patriarchal manner. We passed the night in the same room

with the father, mother, and children of the family. It is true that M. Valenciennes and myself had each a bed to ourselves. These beds, which had four posts and a canopy surrounded with curtains, were raised two yards above the floor, and might have passed at once for a fortress and an alcove; but if our eyes were unable to see beyond its limits, our other senses were keenly alive to all impressions, and they revealed to us many details of domestic management which a more refined host would have been at the pains of concealing from his guests. But when once sleep fell upon us our rest was unbroken till we were called by our host. It was four o'clock when we reached the shore. At this moment the sun was rising behind the alluvial lands of Niort and Grip, in the same manner as it might have done on the open sea. Its beams, reddened by a fog that promised badly for the weather, had coloured the mist suspended over the marshes, imparting a blood-red tinge to every patch of water, and giving to the pebbles that were left by the retiring tide a deceptive appearance of burning coals, which contrasted strongly with the sharp cold of the early morning air.

A boat was waiting for us, and favoured by the tide we were soon carried to the entrance of one of the great *bouchots*. Here, upright upon his *acon*, stood a fisherman armed with a kind of large net. Our arrival was the signal for him to begin his fishing operations, and closing the entrance of the *bouchot* with his net he drew it rapidly away at the end of a few moments, and we could not help admiring the

precision with which he performed this difficult task, for it required an immense amount of dexterity to avoid upsetting the fragile bark. We had soon examined the greater number of the fishes which frequent the *bouchots*. They are generally small species, whose size does not exceed that of the Sardine. There are no doubt amongst them some young individuals of larger species, but the number of these is so inconsiderable that these *bouchots* cannot seriously interfere with the multiplication of the fish, and it seems to us that it would be an act of useless severity to interdict the *boucholeurs* from employing their net.

This kind of net and others of similar construction are the only means employed for catching the common shrimp, which is known to naturalists under the name of *Crangon vulgaris*, and which at Saintonge bears the name of *Bouc*. This Crustacean, although smaller than our common prawn, *Palæmon serratus*, the kind which is to be met with at all fishmongers, is scarcely inferior to it in flavour, while its abundance in the bay of Aiguillon brings it within the reach of the poorest inhabitants. The immense numbers which we saw taken reminded M. Valenciennes and myself of the miraculous draughts of fishes recorded in the various legends of the saints. A little after the tide had gone half way down, the boatman plunged his net into the water, and drew it back completely filled. If he left it there for three or four minutes the haul became so heavy that the pole supporting the net threatened to break. In less than half an hour he had collected more than 200 lbs., the

whole of which had been pre-sold to a retail dealer for the sum of three francs, which was not much more than a centime the pound. However inferior the shrimp may be to the prawn, it can only be for want of proper means of transportation that this Crustacean here remains so much below its true value. When once the railways are completed, the inhabitants of the districts of the Aiguillon will find a new source of wealth in this little animal, which at the present day they estimate so far below its real importance.

At Esnandes, as at Chatelaillon, I had been unsuccessful in filling my various tubes and bottles, and when I returned empty-handed from the different instructive and interesting expeditions which I undertook, my instincts as a zoologist revived, and I felt completely disheartened. The Branchellions were of too rare occurrence to afford me materials of work for a whole season. It was with great difficulty that I obtained five specimens during my stay of more than two months. Fortunately the sea was at length more favourable to me, whilst the land itself contributed its contingent to my studies. The storms from the south-west, which had changed the summer into a rainy and cold autumn, brought into the waters of these coasts some of those strange animals which swarm in the tropical seas, whilst on every side around me I encountered in my country rambles the colonies of one of those insects, which have attracted the attention of the naturalist by the singularity of their habits, and which indeed appear expressly created to recall man to sentiments of humility,

by the power which they possess, insignificant as they are, of successfully undermining the homes of these lords of creation. Thanks to the *Physalias* and the *Termites*, the loss of the first few days was amply repaired, and this season, of whose success I had nearly despaired, proved ultimately to be one of the most favourable that I had ever enjoyed.

Passing over the Physalias and the important questions of philosophical anatomy which have been excited by their strange organisation, we will for the present limit ourselves to the consideration of the Termites. This name has been given to insects belonging to the order of the Neuroptera, and which by their most essential characters approximate to the *Libellulæ*, or Dragon-flies, which are well known to all French readers under the name of *Demoiselles*. But although they belong to the same zoological group, these insects exhibit widely different habits.

The Dragon-flies are essentially carnivorous. Like almost all animals of prey, they pass their life in isolation; and only associate with other individuals of the same species, in obedience to the laws of reproduction. In the conditions of larva and pupa they live at the bottom of our ponds and brooks. Here, imbedded in the mud, they wait patiently until some insect or mollusc, or even some young fish, comes within their reach. They then uncoil a very singular kind of weapon, something like the spring of a watch, which represents in them the lower lip. This is a sort of animated mask, armed with serrated and strong pincers, and supported by articulated pieces, the entire length of which equals that of the body

itself. This mask acts at once like a lip and an arm, seizing the prey in its passage and conveying it to the mouth. When the time of its metamorphosis arrives, the larva draws itself out of the water in which it has lived for nearly a year, and climbs slowly up some neighbouring plant, where it suspends itself with its head downwards. The sun soon dries and hardens its skin, which suddenly bursts and splits. The Dragon-fly first disengages its head and its thorax; its legs and its wings, which are still soft and without strength, gradually become firmer as they are brought into contact with the air, and in the course of a few hours they have acquired all their vigour. The Dragon-fly then at once abandons the dull and muddy covering, in which it had been so long enveloped, throwing it from it like a cast-off garment; and having become a perfect insect, it darts forward in search of prey. It may then be seen hovering round its native pools, sometimes poising itself like an eagle or vulture, and sometimes, describing rapid circles, it falls like a dart upon some unfortunate insect, which it seizes and devours without pausing in its flight. Love scarcely softens for more than a day the disposition of these ferocious insects, and when they have satisfied the common law of nature and secured the propagation of their species, they die in the same isolation in which they have lived.

The Termites, their kindred, are of a far more sociable character, for they, like bees and ants, combine together into numerous societies, in which individuals of different form represent various castes and

perform distinct functions. The singular habits of these insects, which render them so formidable, have given rise to many fables. It is probable that the Termites are those ants which according to Herodotus inhabited the country of the Bactrians, and which, smaller than a dog, although larger than a fox, devoured a pound of meat each day. Living in remote sandy deserts, these gigantic insects dug subterranean habitations, and raised up hills of golden sand which the Indians carried away at the peril of their lives. According to his usual custom, Pliny endeavoured to make this marvellous history still more wonderful, by adding that the horns of these ants might still be seen in the temple of Hercules. Almost in our own day even, and when the Termites were tolerably well known, some travellers have apparently found it difficult to content themselves with facts, although these are certainly curious enough of themselves. It has for instance been stated that these insects possess so active a poison, that merely to respire the emanations proceeding from them was sufficient to produce death, and that a single bite excited a mortal fever. An English naturalist, Smeathman, has thoroughly analysed these narratives, and the facts which he gives us in relation to the exotic species, are not less marvellous than the errors propagated by his predecessors.* This, however, is a result which very often occurs, for, in respect to the marvellous, nature almost always exceeds all that has been devised by human imagination.

* *Some Account of the Termites which are found in Africa and other Climates* (*Philosophical Transactions*, 1781).

Like the great majority of insects, the Termites proceed from an egg, and before they assume their definite forms, undergo various metamorphoses.* In every Termites' nest we meet with larvas, nymphs, and perfect insects, accompanied by an immense number of neuters. Among bees and ants, the latter play the part of the workers, but amongst the Termites they fulfil the functions of soldiers, and are exclusively charged with watching over the common safety, as well as in maintaining good order. The larvas and nymphs, instead of wasting in complete inactivity the time destined for their metamorphoses, perform all the labours that are required in the community. It is they which erect their edifices, dig the mines, amass provisions, and surround the common mother, whose eggs they receive and cherish.

Although charged with the performance of the most laborious duties, they are of very small size; the workers of the *Termes bellicosus*, which is the largest of the species observed by Smeathman, are only about one-fourth of an inch long, while twenty-five of them scarcely weigh a grain. They are not, therefore, larger than our ants, which they so much resemble that the same name was long since given

* Every insect that undergoes complete metamorphosis, passes successively through three different stages. On coming forth from the egg, it bears the name of larva. Thus, for instance, the caterpillar is the larva of the butterfly. In its second stage, it takes the name of nympha or pupa, or chrysalis in the case of the butterfly. It then finally becomes a perfect insect, and it is only after it has attained this stage that the different sexes can be distinguished, either by external or anatomical characters.

to them.* Their entire body is of such extreme delicacy, that they are crushed by the slightest touch; but their head is provided with serrated mandibles, of so strong and horny a substance as to enable them to attack the hardest bodies, excepting only metals and stones. The soldiers are about double their length, and weigh as much as fifteen of the workers. This excessive weight is due to their enormous horny head, which is much larger than the body, and is armed with sharp pincers, true weapons of offence which cannot serve for purposes of ordinary labour. Finally the perfect insect is sometimes as much as six or seven-tenths of an inch in length, it weighs as much as thirty workers, and the wings which it possesses only for a few hours, are two inches and a half from tip to tip. We shall presently see what singular modifications appear to have been impressed upon the females by the very nature of the part which they are destined to play.

All the species of the Termites are miners, and most of them, moreover, are architects. Some among them build their nest on trees around a large branch, which these destructive insects well know how to respect when it suits their purpose. These nests are often as large as a sugar barrel, and although they present a broad purchase to the storms of the tropics, and are composed entirely of small parcels of wood, glued together by means of the gums of the district, and the juices yielded by the workers themselves, they are never torn away. Very few species live in the open air, for the greater number construct

* The Creoles and most travellers still designate the Termites by the name of *white ants*, on account of their shape and colour.

above their subterranean galleries, edifices that enclose their storehouses and nurseries. The *Termes atrox* and the *Termes mordax* thus erect true columns surmounted by a roof or dome, which projects on all sides. These columns are about three-quarters of a yard high, and about a quarter of a yard in width. They are entirely constructed of a sort of clay, which acquires an extraordinary degree of hardness after it has been worked by the Termites. It is easier to tear up one of these columns from its foundation than to break it through the middle. The interior is hollow, or rather it is entirely composed of irregularly-shaped cells, which serve as lodgings. When the number of the inhabitants augments a new column rises by the side of the former one, and so on, until the nest of one of the two species which I have named, bears no inconsiderable resemblance to a group of monstrous toadstools.

If, however, we would see the Termites display all the industry that the Creator has bestowed upon them, we must follow the example of Smeathman, and visit and demolish piece by piece a nest of the *Termes bellicosus*. When a colony of the latter establishes itself in the midst of a plain, one or two conical towers are first observed to protrude above the surface of the ground, and, growing rapidly, they soon multiply and attain a height of five feet. The extent of the soil occupied by these temporary edifices corresponds with that of their subterranean works. The diameter of these towers gradually increases, their base extends, and in a short time they touch one another and become cemented together.

The void which before had separated them then rapidly disappears, and in less than a year the nest presents externally the appearance of an irregularly conical hillock, having around it a dome-shaped summit, bearing on its sides a variable number of elongated eminences, and having at its base a diameter of five or six yards, with nearly the same degree of height.*

If we take into account the difference of size of the architects, we find, on comparing the hillocks constructed by these insects with the most colossal monuments erected by the hand of man, that the result is such as to excite in us a sentiment bordering on humility. The pyramid of Cheops was, at the time of its construction, and before the base had been blocked up by the accumulation of sand, 479·640 feet in height.† It was, consequently, then about ninety-six times the height of a man, if we assume the average human stature at five feet. From what we have already said in respect to the size of the Termites, and of the hillocks which they erect, the

* Smeathman does not ascribe more than a height of ten or twelve feet to the nests of the *Termes bellicosus*, but Jobson in his *History of Gambia* says that he has seen them as high as twenty feet. All travellers, moreover, are agreed as to the extreme solidity of the domes erected by these insects.

† I use the name consecrated by custom, but M. Ampére assures me that we ought to read *Choufou* instead of Cheops. The following are the dimensions of this pyramid, as given in 1837 by the English architect Mr. Perring:—

	Feet.
Length of the base in its primitive condition	767·424
Height in its primitive condition	479·640
Actual length	746·000
Actual height	450·750

latter must be about a thousand times higher than the height of the insects which constructed them. Thus, if we take all the different proportions into account, we find that these edifices of the Termites are relatively eleven times higher than the loftiest of our monuments. In order to reach to an equal height, the great pyramid must be elevated more than a mile above the ground, which would give a height superior to that of the Puy de Dôme.

These artificial hills possess a degree of solidity that is proof against most attacks. While they are still in the course of construction, and when their rounded domes are accessible to the wild bulls, these animals may often be observed standing on their summits as sentinels to the rest of the herd. Smeathman, Jobson, and other travellers, were in the habit of climbing up to the top of these hillocks in order to obtain a view of the surrounding country; or they lay in ambuscade among the turrets of these edifices in order "to shoot at deere or wild beasts," and yet these columns and hillocks are entirely hollow. Situated in the centre of the ground worked by each colony, these edifices may be said to constitute the capital of the community; and like our own large cities they have their public streets and squares, through which a numerous population is seen passing to and fro; their magazines always well filled with provisions; their foundling hospitals, in which new generations are reared by the care of the community; and, lastly, the palace of their sovereigns, who are in truth the actual father and mother of their subjects.

I would advise my readers to consult the curious sketches which Smeathman has made of different sections of these hillocks. On examining his drawings we first see the walls, which are as hard as brick, and measure from one to two feet in thickness. More or less cylindrical galleries pierce these walls, and increase in diameter towards the base, where the largest of them are as much as fourteen inches in width, and penetrate between four and five feet under ground. These subterranean galleries are at once quarries and drains for carrying off the extra moisture. It is from here that the materials necessary for the erection of the building have been obtained, while in case of inundation they carry off the water to a considerable depth below the soil, and thus prevent it from reaching the populous quarters of the nest. The other galleries, which pass obliquely in every direction, intersect one another, and by extending to the dome and to the smallest turrets they serve as routes which are used by the workers engaged in building operations. Even this does not constitute the town itself, but is rather to be considered as its ramparts.

The whole of the interior is not quite filled. Below the dome lies a large free space, occupying the entire width of the hillock. The height of these attics equals very nearly the third of the total elevation. The ceiling is flat and has no opening in it, but some of the galleries which run through the general envelope open on a level with it. Other galleries open at different heights, and are continued by steps resting against the wall like the stairs in

the interior of the cupola of the Pantheon. These are so many scaffoldings, which enable the workers to reach every part of the vault. As to the attics, they serve the part of a double flooring, or an air-chamber, whose utility may be readily understood when we consider the intense noon-day heats and the bitterly cold nights of those regions. This upper chamber thus secures equable temperature throughout the entire building, whilst it screens the nurseries, which are situated below it, from daily variations of heat.

Having passed in review the walls, cellars, and attics of the building, we will now proceed to the apartments themselves. On a level with the soil, and on the centre of the ground floor, rises the palace of the sovereigns, which we are now about to describe. This royal chamber is a large oblong cell, with a flat floor, and a rounded vault, which when first formed measures about an inch in length. The walls are very thick, more especially in the lower part, and are pierced with round doors and windows, at regular distances from one another. All around the sanctuary, extending for a space of more than a foot in diameter in all directions, there appears a perfect labyrinth of vaulted chambers, which are always round or oval, and which either communicate freely with one another, or open into wide passages. These are the waiting rooms, exclusively appropriated to the use of the workers and soldiers, who are in attendance upon the royal pair. On the sides rise, to the very roof of the attics, storerooms which line the walls of the general covering. These are large irregular cells,

which are always filled with gums and the solidified juices of plants, reduced into such minute particles, that the microscope alone enables us to recognise their true nature. Galleries and small empty cells connect together all these well-stored chambers, and secure a free passage to the attendants.

The royal chamber and its dependencies are protected by a thick vault, the upper part of which serves to support a large empty space, situated in the very centre of the hillock. On this kind of area, rise massive columns, which are sometimes more than three feet high, and which give to this vast hall the appearance of the nave of a cathedral. These pillars support the nurseries, which differ from the rest of the edifice as much in their structure as in the objects for which they are intended. In every other part of the edifice, clay is the only material employed, and even in the nurseries it forms the skeleton of the cells; but here the large apartments in which the eggs are to be hatched, and in which the very young larvas remain for a time, are subdivided into a great number of little cells, whose walls are entirely constructed of parcels of wood, glued together with gum. Nurseries of this kind are found of all sizes, and some of them are as large as the head of a child. All of them are surrounded by a casing of mason work, interrupted by doors which open into the galleries or passages of communication, and being situated between the large air-chamber of the attic and the nave of which we have just spoken, they combine all the conditions favourable to equability of temperature and ventilation.

We will now return to the royal chamber, which on being broken open is always found to enclose the one couple, who are the objects of the most assiduous care, but who purchase their greatness at the cost of perpetual seclusion; for the doors and windows of the chamber, although sufficient to admit of the passage of a worker or a soldier, are too narrow to enable the king, and *à fortiori* the queen, to pass through them. The royal mother of the community, who always rests on the ground in the centre of her habitation, at once attracts the attention of the observer. How slightly does she resemble that graceful insect with delicate wings and slender form, which was only three or four times the length and thirty times the weight of a worker! Her wings have disappeared, but while her head and thorax remain almost unchanged, her abdomen has on the contrary acquired an enormous development, which seems to have no limit. In an old female, it is fifteen hundred or two thousand times larger than the rest of the body, and it reaches a length of nearly six inches. At this time her weight is equal to thirty thousand workers, and in consequence of this excessive enlargement, the precautions taken to prevent her flight are perfectly useless, for she is unable to advance a single step. The male also has lost his wings, but he is not changed in any other respect either as to dimensions or form. Nevertheless he makes little use of his power of locomotion, and is generally hidden under one of the sides of the vast abdomen of his companion.

The workers and soldiers appear to pay very little

attention to the king, but their devotion to the queen is excessive. The space that is left free round the latter is constantly filled by several thousand eager attendants who move round her, always turning in the same direction. Some feed her, others remove the eggs which she is unceasingly laying, for here, as in the case of the bees, the queen is the actual mother of her subjects, and her productiveness is truly marvellous. If it were not for the immense number of labourers which each colony must contain in order to accomplish such vast works, it would be difficult to believe the details which Smeathman declares he has repeatedly verified. This monstrous abdomen seems to be nothing but a vast ovary, whose multiplied branches enclose so large a number of germs in the course of development that there are always some that have reached maturity. These canals may be seen through the attenuated and transparent integuments presenting incessant peristaltic or vermicular motions, first at one point and then at another. By means of this mechanism, the female Termite, probably almost involuntarily, lays upwards of sixty eggs in a minute, that is to say, more than 80,000 in a day, and Smeathman is led to believe that this prodigious quantity is deposited with the same activity throughout the whole year.

These myriads of eggs being promptly collected are carried into the nurseries, and very soon there issue from them a like number of larvas, similar to the workers, but smaller in size, and of a snow-white colour. These larvas continue to live for some time in the cells in which they were hatched. Here they are the objects of the most attentive care, the

very walls which shelter them seeming to be changed into hot-beds to furnish materials for their nourishment. Owing to the humid heat which prevails at all times in the centre of the nest, the partitions of wood and gum which form the nurseries are soon covered with microscopical fungi, very similar to our mushrooms, and the young Termites find in this mould a species of food adapted to their early wants. They no doubt undergo some first metamorphosis, and subsequently assume the form of the active labourers or soldiers. The former alone attain the condition of perfect insects.

Towards the beginning of the rainy reason, their wings become fully developed, and selecting some stormy evening for the period of their flight, the males and females issue by millions from their subterranean retreats. Their aërial life is, however, of very short duration, for after a few hours their wings wither and fall off. On the following day the earth appears thickly strewn with the bodies of these hapless insects, and being henceforth incapable of flight, they fall an easy prey to the thousand enemies who are anxiously watching for this annual food. Only a small number escape the general massacre. A few couples, collected by the labourers, and protected by the soldiers which chance has led near them, return into their galleries, and generally become the sovereigns of those who have saved them. Soon enclosed for ever within the royal cell, they form the nucleus of a new community, and have nothing more to think of but to endeavour to augment the numbers of their subjects.

All travellers speak of ants being used by certain

nations as an article of food. This remark, however, applies only to the Termites, and there is no doubt that man must be classed among the enemies who annually watch for the emigration of these insects, with the view of securing them for food. The Indians smoke the nests, and stop the winged insects as they are hastening to escape from their habitation. The natives of Africa, with less industry, content themselves with collecting those which fall into the neighbouring waters. The Indians pound these insects into a paste, and mixing them with flour convert them into a sort of cake; while the Africans content themselves with roasting them very much in the same manner as coffee beans, eating them by handfuls, and declaring that they thus constitute a most delicious article of food. However strange such viands may appear, they seem to be relished even by Europeans, and all travellers agree in speaking of the Termites, as a savoury and agreeable article of food, resembling in flavour sweetened marrow or cream. Smeathman regards them as a delicate, nourishing, and wholesome food *, and he seems even to prefer them to those famous palm grubs, which in the West Indies are brought to the tables of the rich as an exquisite delicacy.†

* It would appear, however, that the abuse of this food engenders very serious diseases, and amongst others a kind of epidemic dysentery, which carries off the patient in three or four hours.

† These grubs, which take their name from the locality in which they are found, are nothing but the larva of a kind of weevil, *Calandra palmarum*, which during the first two stages of its development inhabits the trunk of the palm tree. Some naturalists are of opinion that the larva is the same as that which the Romans

The neuter Termites preserve through the whole of their lives the characters and attributes which have obtained for them the name of soldiers. Although they hardly number one hundredth part of the population of the Termites, they constitute a separate class which a writer of the last century would undoubtedly have compared to the nobility of a monarchy, whilst the larvas would have represented the plebeians of the community. At ordinary times they live idle, keeping guard or merely watching the labours of the workers, over whom they exert an evident authority. In times of war they bravely risk their persons, and sacrifice themselves, if necessary, for the common safety. At the first stroke of the pick-axe, which lays open one of their galleries, the nearest sentinel is observed to hurry forward. The alarm spreads, and in the twinkling of an eye a crowd of combatants cover the breach, moving their large heads in all directions, and opening and shutting their forceps with a loud noise. When once they have seized any object, nothing will make them relinquish their hold, they will allow their limbs and body to be torn in pieces without unlocking their jaws. If they can reach the hands or legs of the

regarded as so great a delicacy, and which they fattened with flour. The idea of eating worms would not be very inviting to our epicures, but this perhaps may arise from mere prejudice. We were assured some time ago that a worthy citizen of Geneva, with the view of effecting the destruction of the cockchafers, suggested that their larvæ might be used as food, and not only eat them himself, but persuaded many of his friends to follow his example, and it was asserted that they were found remarkably good when fried in batter.

aggressors, they at once draw blood. Each Termite will cause a loss of blood exceeding the weight of its own body. Thus the negroes who are without shoes and only half-clothed, are soon put to flight, whilst even Europeans leave the combat with their clothes deeply stained with blood.

While they are engaged in fighting, the soldiers strike the ground from time to time with their forceps, and the labourers reply to this well known signal by a sort of whistling sound. As soon as the attack ceases, the masons appear in crowds, each carrying in its mouth a piece of clay ready prepared. Each in turn approaching the point that needs repair, applies to it his portion of mortar, and then again retires without embarrassing or interfering with his companions. The new wall is rapidly constructed under the eyes of the observer. During this time the soldiers remain in the interior, with the exception of one or two to every thousand labourers. One of them appears to be charged with superintending the works; for during the building of a wall, he stands as a superintendent, slowly turning his head in all directions, and striking the dome rapidly every two or three minutes with his forceps, which produce a noise rather louder than that of the ticking of a watch. This noise is each time responded to by a whistling sound, which proceeds from all parts of the edifice, and is invariably accompanied by an exhibition of increasing activity on the part of the labourers. If the attack recommences, the labourers disappear in the twinkling of an eye, and the soldiers return to their posts, where they maintain the con-

test with the greatest obstinacy, defending the ground inch by inch. The labourers in the meantime are not idle, for they block up the passages and galleries and appear especially anxious to guard their sovereigns. With this intention, they fill up the waiting rooms with the greatest possible celerity, and effect their purpose so completely that Smeathman on reaching the centre of one of these edifices, was unable to distinguish the royal chamber, which was lost in the midst of a shapeless mass of clay. The vicinity of this palace is however betrayed by the crowd of labourers and soldiers, who are collected around it, and who allow themselves to be crushed, rather than abandon the spot. The cell itself always contains several thousands of the community, who have remained and suffered themselves to be immured with the royal pair. Smeathman always found that they readily allowed themselves to be carried away with these objects of their devoted attachment, and that they continued their services in captivity, being incessantly engaged in moving round the person of the queen, giving her food, and removing her eggs, which, for want of nurseries, they deposited behind broken pieces of clay, or in some retired portion of the bowl which served as their prison.

It is scarcely possible to obtain a view of the Termites without destroying their works. Chance may, indeed, sometimes enable the traveller to see a colony of these insects while they are proceeding from one habitation to another, as in the case of Smeathman, who had the pleasure of seeing one of

their armies march by him*, but in general they do not appear above ground. Every nest that is built on a level with the soil or below it, is characterised in all the species by having subterranean galleries, which radiate in all directions, and often to very considerable distances from the point of their origin. Even the Tree-Termites construct a long tube which reaches to the ground and serves as the centre of their covered roads. All the species, moreover, have the same habits, and their innumerable squadrons are incessantly on the watch to discover some organic body which they may devour; and this instinct renders them so formidable to man, that Linnæus has not hesitated to designate them as the greatest scourge of the Indies.†

Invisible to the eyes of those whom they threaten, the Termites carry their galleries to the very walls of inhabited buildings or storehouses, descend beneath the foundations, and make their way up again through the interior; and from this time they are entire masters of the place. Some attack the woodwork, the furniture, and provisions of every kind, whilst others, without deviating from their course, demolish the floors and roofs; but being always careful of avoiding the light, they scrupulously respect the surface of the objects which they attack and content themselves with gutting the interior. If the spot appears favourable to them and there seems much to

* This species is different from those of which we have hitherto spoken, and our author gives them the name of *Marching Termites* (*Termes viarum*).

† "Termes utriusque Indiæ Calamitas summa." — *Systema Naturæ.*

be attacked, they bring with them mortar to replace, piece by piece, the woody structures which they have destroyed; and Smeathman has seen wooden posts thus changed into hard clay columns. If the contrary be the case, they are less cautious, and their work of destruction progresses with such amazing rapidity that one season suffices for the complete destruction of a house built in the European fashion, while a negro village completely disappears within the same period. They have been seen to penetrate in a single night through the foot of a table, and traversing the leg from below upwards, to attack a box which was standing upon it, and so completely to destroy the contents that the next day not an inch of the clothing which it contained was found to have escaped their attacks; and even papers, drawings, and pencils, including the lead, had all disappeared in the same time.

Of the different species of Termites described by naturalists, two only appear to occur in Europe.* Both are exclusively miners, and their nests, which are difficult of detection, have not been studied like those of their congeners which raise their habitations

* We are certainly far from knowing all the species of Termites which inhabit the two continents, and the distinctions between those that have already been described are by no means perfectly defined. It would appear, however, from the memoirs of various authors, that there exist at least twenty-four distinct species of these insects, nine of which belong to Africa, nine to America, two to Asia, and two to Europe. We do not yet know the habitats of the remaining two. The two European species occur in France, and we shall presently see that there are reasons which lead to the supposition that we possess a third.

above the soil. For the same reason their habits and internal economy are very little known; but it is only too easy to discover in our indigenous Termites the same destructive instincts which are possessed by their exotic brethren. In Sardinia, Spain, and the South of France, the species known as the *flavicollis* attacks the olives and other valuable trees, while in the Gironde and the Landes the *T. lucifugus* devours the oaks and fir trees. Here we are led to ask if it is one of these two species which, renouncing a country life and accommodating itself to our towns, is at present exercising its ravages at La Rochelle, Rochefort, Saintes, and the neighbouring districts? It must be admitted that, notwithstanding the affirmative reply that has been given by some of our most distinguished entomologists, the question seems to us at all events very doubtful.

Latreille, who was one of the founders of modern entomology, informs us that the *T. lucifugus* of the neighbourhood of Bordeaux reaches the condition of a perfect insect, acquires wings, and emigrates in the course of the month of June. On the other hand, a much less celebrated observer, but one who studied the Termites of Rochefort on the spot for nearly half a century, affirms that in that town their emigration takes place in the month of March, and that when that epoch is passed there is not a winged Termite to be seen.* Those who are acquainted with the precision of the laws which regulate the development of organised beings, will consider that

* *Mémoire sur les Termites observés à Rochefort*, by M. Bobe-Moreau. Saintes, 1843.

this difference of two months between the two periods of the metamorphosis is quite sufficient to raise doubts as to the identity of the species, and the more so in this case because it is in the more southern region that the metamorphosis is reported to be the latest. If the observations of Latreille on the *lucifugus* of the Landes had been repeated and confirmed, and if M. Blanchard had not found winged males in the nests at La Rochelle in the month of September, the fact that we have recorded would of itself seem almost sufficient for the solution of this question.

Other facts, which we must bear in mind, are moreover in opposition to the generally received opinion. Unless under very exceptional circumstances, the same instincts occur in all the representatives of the same species of animals. In insects more especially we cannot admit that these instincts vary with the locality, or, in other words, that they differ in different colonies. In Provence and in the neighbourhood of Bordeaux, Termites are found only in the country, and far from following man into the towns, they seem even to avoid all rural habitations. If this were not the case, and if the Termites of the Gironde, like those of Senegal and of Charente-Inférieure, penetrated into all warehouses, and breaking through the hoops which encircle the tuns, occasioned the loss of the wine, the Medoc wine owners would assuredly have spoken of the damage done to their property, and yet, as far as I know, they have never made any complaints on the subject.

No mention is made in historic times of the pre-

sence of the Termites in Saintonge any more than in the country round Bordeaux; indeed no naturalist had ever mentioned their occurrence in the basin of the Charente until they suddenly appeared in the very heart of the town of Rochefort, where they spread rapidly day by day, until now, after the space of half a century, they have successively invaded several other towns, infested the gardens, attacked numerous isolated houses, and even threaten to overrun the entire district.* Is it probable that these insects should be of the same species as the *lucifugus*, and that, changing the country habits which they exhibit in La Gironde, they should have accommodated themselves to a town life in Saintonge? † Is it not more reasonable to assume that the Termite of Rochefort is a new species, or at least new to this district, which having been imported by

* According to M. Bobe-Moreau, Termites were not discovered at Rochefort until 1797, when they were found in a house that had long been uninhabited, in which they had destroyed the greater part of the woodwork together with all the furniture. After this, they spread to the neighbouring houses. In 1804, their progress was not yet very great, for Latreille mentions that there is a report that the *Termes lucifugus* had for the last few years given much uneasiness to the inhabitants of Rochefort, in consequence of these insects having made their way into several of the houses. In 1829 the same writer spoke in a very different strain of the damage done by these insects in the workshops and magazines of the navy.

† M. Lucas, member of the scientific commission sent by government to Algeria, has found in that country the *T. lucifugus* and the *T. flavicollis*. He has only met with the first of these insects in the country, the second alone penetrates into inhabited houses. Thus wherever the *T. lucifugus* has been observed in its native state, it has shown habits which differ from those exhibited by the Termites of Rochefort.

some merchant vessel, like certain of the Blattæ, has come no one knows from whence, as if to prove to us that travellers have been guilty of no exaggeration in speaking of this scourge. A rigorous comparison of these insects in all their different stages, and a thorough investigation of their origin, would alone be able to settle this question.*

Whatever may be the true state of the case, La Rochelle has undoubtedly experienced the same fate as Rochefort, Saintes, and Tonnay-Charente, and on arriving at the first-named town, I felt assured that I should find these destructive insects.

I was well aware of the damage which they were capable of accomplishing, for MM. Audouin, Milne-Edwards, and Blanchard had frequently traversed the department of the Charente-Inférieure, and brought back with them to the Museum of Paris several material proofs of the dangers, which those apparently insignificant enemies are capable of inflicting on the inhabitants of these districts. These naturalists had described the sudden manner in which the roofs and floors of houses had crumbled to pieces, and how some buildings were found to be so entirely undermined, that it was necessary either to reconstruct them from the very foundations, or entirely to abandon them. I was very soon able to judge for myself of the accuracy of these reports, although La Rochelle is not nearly so completely infested as the

* M. Blanchard has already directed his attention to this subject, and we ought to mention that his first results are not favourable to our views. The materials, however, at his disposal were by no means complete.

other towns to which I have referred. Here the Termites have only taken possession of the Prefecture and the Arsenal.* And in consequence of these insects not having made any marked progress for some years past, the Rochellais appear to believe that they will never exceed their present limits. This is most certainly an error, and whenever the season should be a little more favourable than usual to the development of these insects, the whole town may be infested in the course of a few months, and the Rochellais will then too late deplore the imprudent security which led them to neglect to seek for the necessary means of destroying these enemies, which at present are quartered at the two extremities of the town.

The Prefecture and a few neighbouring houses are the principal scene of the destructive ravages of the Termites, but here they have taken complete possession of the premises. In the garden not a

* This installation of Termites at two perfectly isolated points, which are situated almost at the two extremities of the town, and the absence of these insects from all the central part of La Rochelle, demonstrate most clearly that they are not natives of this portion of the department. M. Blanchard indeed admits their importation into La Rochelle. From information which I have obtained through M. Beltremieux, this importation took place about 1780, when the brothers Poupet, rich shipowners of that day, were building the hotel or mansion which was afterwards converted into the Prefecture. It would appear that goods which had come from Saint-Domingo were the means of introducing the Termites not only into La Rochelle but also into Rochefort, and several other points where the brothers Poupet had warehouses. This traditionary account agrees tolerably well with the date which M. Bobe-Moreau gives for the discovery of the Termites at Rochefort, and would also explain their progressive invasion.

stake can be put into the ground, and not a plank can be left on the beds, without being attacked within twenty-four or forty-eight hours. The fences put round the young trees are gnawed from the bottom, while the trees themselves are gutted to the very branches. Within the building itself, the apartments and offices are all alike invaded. I saw upon the roof of a bedroom that had been recently repaired, galleries made by the Termites which looked like stalactites, and which had begun to show themselves the very day after the workmen had left the place. In the cellars, I discovered similar galleries, which were either half way between the ceiling and the floor*, or running along the walls, and extending no doubt up to the very garrets, for on the principal staircase other galleries were observed between the ground floor and the second floor, passing under the plaster whenever it was sufficiently thick for the purpose, and only coming to view at different points where the stones were on the surface; for, like other species, the Termites of La Rochelle always work under cover wherever it is possible for them to do so. It is generally only by incessant vigilance that we can trace the course of their devastations, and prevent their ravages. At the time of M. Audouin's visit, a curious proof was

* MM. Milne-Edwards and Blanchard have seen galleries which descended without any extraneous support from the ceiling to the floor of a cellar. M. Bobe-Moreau cites several curious instances of this mode of construction; thus for instance, he saw isolated galleries, or arcades, which were thrown horizontally forwards like a tubular bridge, in order to reach a piece of paper that was wrapped round a bottle, the contents of a pot of honey, &c.

accidentally obtained of the mischief which this insect silently accomplishes. One day it was discovered that the archives of the department were almost totally destroyed, and that without the slightest external trace of any damage. The Termites had reached the boxes in which these documents were preserved, by mining the wainscoting, and they had then leisurely set to work to devour these administrative records, carefully respecting the upper sheets and the margin of each leaf, so that a box which was only filled with a mass of rubbish, seemed to enclose a file of papers in perfect order. The hardest woods are attacked in the same manner. I saw on one of the staircases an oak post, in which one of the clerks had buried his hand up to the wrist, in grasping at it for support as his foot accidentally slipped. The interior of the post was entirely formed of empty cells, the substance of which could be scraped away like dust, while the layer that had been left untouched by the Termites was not thicker than a sheet of paper.

Immediately on my arrival, I endeavoured to procure a number of Termites, in order that I might observe them at my leisure; and thanks to the kind attention of Doctor Garreau, one of the members of the Society of Natural History, I constantly had a supply of them on my table. It will be readily understood that I took every precaution to avoid their escaping, for had they got abroad, they would undoubtedly have destroyed the house, and in the course of time the part of the city in which it was situated. I kept these insects in a basin that was only half

full, and took every precaution to screen them from the light; and, as my prisoners were unable to scale their glassy walls, I could observe them at my leisure; and I was thus enabled to follow in detail the various steps by which they transformed into a regular nest the confused mass of earth and rubbish, in the midst of which they had at first been thrown.

A very few minutes after the bowl had been placed on my table, each insect endeavoured to join his companions. Some attempted to climb along the smooth walls of their prison, but after a few unsuccessful attempts, they buried themselves in the midst of the earth. The entire troop was soon dispersed, and I saw them divided into small groups on the darkest part of the bowl. After a few hours the various groups were reunited into one, and from this moment their labours began and were continued in common.

The first care of the Termites seemed to be to lay down a sort of high road all round the bowl, and as the materials were very unequally distributed, they were obliged to clear away some parts, and to fill up others. The first of these tasks was easy, but the second gave them more trouble. The workmen first transported a certain quantity of earth, intended to raise the soil to the required height, and they next constructed an arch above it. I saw them come one after the other, each carrying between his jaws a little mass of earth, which he applied without pausing to the projecting edge of the work; next he descended by a kind of incline which had been expressly constructed for the purpose, and returned

under ground by a special gallery. Some of these insects appeared to me to moisten the materials after they had been put in their right places with a liquid, which was no doubt intended to harden them. During these labours, the soldiers were most evidently engaged in playing the part of leaders and superintendents. I saw one here and there, and always alone, mixing amongst the labourers but never performing any of the work. At times they made a sort of tremulous motion with the whole of their body, and struck the ground with their forceps, on which all the neighbouring workers executed the same movement and exhibited renewed activity. In twenty hours the circular gallery was fit for use. It must be admitted, however, that the walls of the bowl formed almost half of it. At the same time the earth had been consolidated, and its surface smoothed, whilst a cork which I had thrown in was half buried. I then gave them three other corks, and added successively a closely compressed paper ball and a large ball of bread crumbs. These different materials remained precisely in the same position in which they had accidentally fallen, and I thought at first that they had been despised by the Termites, but having after a few days turned the bowl completely over, I found that they all remained in their places notwithstanding their weight. They had, in fact, been cemented together, and I discovered afterwards, on opening them, that the insects had carried their galleries through them, although the work of cementing and boring could not be discovered from the exterior.

The labours of my prisoners appeared at first to be continued without any intermission, but they were relaxed as soon as the great works were terminated. A few days, however, sufficed for the completion of the nest, and this time the largest cork had almost entirely disappeared, whilst the earth had been raised to the level of the other two. All the surface of the soil was smooth, without any apparent opening, and the earth, which at the beginning of the experiment was as loose as fine sand, had been so well consolidated, that only a few particles were detached from it when the bowl was overturned. Under this kind of crust, and at the very bottom of it, there extended all round the bowl, a gallery about half an inch wide, and two thirds of an inch high, in the form of a semi-arch, which rested against the transparent sides of the glass. Several openings issued from this circular road, and gave access into low vaulted chambers, large enough to contain thirty or forty workers. These compartments communicated with other internal cells, by means of very low doors, through which five or six workers could pass abreast.

As soon as this work was completed, the Termites remained at rest, at least during the day. I generally found them grouped together in the darkest part of the large gallery, or in the adjoining compartments, whilst a few isolated soldiers seemed occasionally to mount guard at the entrance of the empty cells, but as soon as the light struck them, they manifested an intense degree of excitement. Labourers and soldiers then performed the singular and tremulous

movement of which I have already spoken, and in a few moments all had disappeared into the central apartments, where the light could not penetrate.

Curiosity was not the only motive which influenced me in making my observations. In studying the manners of the Termites, and endeavouring to form a correct idea of the construction of their habitations, I was more especially influenced by the wish of discovering means of destroying these enemies, whose numbers and minute size have rendered them almost invincible. MM. Audouin, Milne-Edwards, Blanchard, and Lucas had never made any prolonged stay in the district, and consequently had been unable to enter systematically upon this question, but many other observers had attempted to solve this problem. Different methods had been employed for protecting the gardens and fruit trees, and, amongst other expedients, recourse had been had to sprinkling with tar water, ploughing the land frequently and to a great depth, and digging circular fosses round the trunks of the trees. Essence of turpentine and powdered arsenic have been suggested as means for destroying those insects in their nests, and one traveller assures us that the latter substance has perfectly succeeded at La Martinique.* Unfortunately, however, these various processes have always failed in the department of Saintonge, and the injections of boiling potash lees, which have recently been tried, are evidently inapplicable in most cases.†

* Chauvallon (*Voyage à la Martinique*). A letter which I have received from an unknown correspondent in America affirms the same fact.

† Madame George, who devotes herself to natural history, and

MM. Fleuriau and Sauvé have also attempted to destroy the colony that has established itself at the Prefecture of La Rochelle. After having tried various methods, but without success, they thought of calling to their assistance the aid of auxiliaries, and of employing Ants to combat the Termites. The application of this ingenious idea would certainly have been attended with some inconveniences, for one destructive insect would only have replaced another; but still the remedy would have been much better than the evil, and it is to be regretted that the attempts of the Rochellais savants were not attended with success. They intermingled in one bowl a nearly equal number of these two species of insects. A battle commenced forthwith, and it was soon easy to foresee the issue of it. The Termites inflicted the deepest wounds, and the soldiers, with a single stroke of their terrible forceps, cut the Ants in two, as with shears. In a little while they were exterminated, whilst the Termites at first counted only a very small number of dead. On the next day, however, nearly one half perished, having very probably been destroyed by the acid which the Ants secrete, and which had poisoned even the smallest wounds.

Notwithstanding the many failures of my predecessors, I entertained strong hopes of successfully

more especially to botany, with a zeal which is very seldom displayed by women, has announced to the Society of Natural History at La Rochelle, of which she is a corresponding member, that she has succeeded by this method in driving the Termites from her garden. Madame George regards the Termite which has invaded her premises as the *Termes nasutus* of Jamaica, but this determination requires to be further confirmed.

attacking the Termites. I relied upon the aid which I might derive from some of those gaseous poisons prepared by chemistry, and which in consequence of their very nature are able to penetrate into the smallest recesses. I had heard one of the founders of modern science relate the manner in which he had exterminated the Rats which continued to infest his house, notwithstanding the snares and traps of every kind which had been employed for their destruction. After having carefully closed all the holes made by these rodents, M. Thénard applied to one of the openings an apparatus from which sulphuretted hydrogen was disengaged, and the Rats being thus imprisoned and compelled to breathe only a vitiated air, were soon killed by the poison.

In consequence of the special mode of respiration of insects, the Termites must be much more sensitive than Rats to the action of a deleterious gas.* In order to render the process of gaseous injection applicable to them, two conditions would be necessary. It would be requisite that their edifices should present a continuous line of galleries and compartments through which the gas might universally penetrate, and this was a point satisfactorily settled by my observations. Next it would be necessary to find a gas which would be as destructive to those insects

* It is well known that in insects respiration is not accomplished by lungs, that is to say, by a localised organ, but by tracheæ or ramified canals, which convey the air into all parts of the body. It will readily be understood that in these animals, a gaseous poison, which is conveyed simultaneously to every portion of the organism, must, all other things being equal, act with the greatest energy.

as sulphuretted hydrogen was to the Rats, and here direct experiments became necessary. A great number of substances which are highly poisonous to Man and to the other vertebrata, exert only a very feeble action on the invertebrata, and more especially on insects. Sulphuretted hydrogen, which was so successfully employed by M. Thénard, is one of these, and hence it was necessary to replace it by some other gas.

Owing to the kindness of M. Robillard, principal apothecary to the military hospital at La Rochelle, the laboratory of that establishment was placed at my disposal. Freshly collected Termites were introduced into vessels which, by way of extra precaution, had been placed in large basins filled with water, and I then proceeded to try the effects of various gases, until I discovered that chlorine completely answered my expectations. When perfectly active Termites are plunged into this gas in a nearly pure condition they at once fall as if instantaneously killed. When left for half an hour in air mixed with only one tenth of chlorine, they are found to be completely asphyxiated. Experiments that were repeated in several different ways, and in which I tried as far as possible to imitate the arrangement of the layers of wood that had been attacked by the Termites, gave equally decisive and equally satisfactory results. Thus, to destroy the largest Termite settlement, all that is necessary is to inject a sufficient quantity of chlorine.

We are far, however, from asserting that all the difficulties of the problem can be met in this simple

manner. In all questions of this kind, practical attempts which alone can decide the applicability of the method, must necessarily follow upon all those investigations of science which yield what may be termed a theoretical solution of a problem. Considered from this point of view, it will be seen that new problems rise for every special case. Thus, for instance, in attacking an exclusively mining species, an exact exploration of the scene of their operations will be the first thing necessary, in order to discover the starting point of the thousand galleries which are constructed by the Termites. Next it would be necessary to determine the spot at which the apparatus should be applied, in order that the gas might penetrate with the fewest obstacles into the very heart of the settlement. Perhaps the insects when thus attacked might defend themselves, like those of Senegal, by walling up the passages which gave admittance to the deleterious gas, and in that case it would be necessary to display a promptitude of action which would be the only means of forestalling the efforts of these little animals. Perhaps it would be necessary to liberate the gas under a pressure high enough to enable it to penetrate through the whole extent of these edifices. Perhaps, indeed, notwithstanding all these precautions the first attempts might prove unsuccessful, even in the case of isolated colonies like those of La Rochelle. Lastly, it is very probable, or rather almost certain, that in towns which have been generally infected like Saintes or Rochefort, it would be necessary, after a first success, to contend against new invasions, and

to recommence from time to time a fresh course of experiments and operations. But we may ask if the farmer succeeds in freeing himself in one season from noxious weeds and tares. He, too, requires activity and perseverance to protect his harvests; and this is all we ask of the proprietors of the houses or lands which are being undermined by the Termites, and at this cost alone can we guarantee them success in their endeavours.

Since the publication of the original edition of this work, a very careful series of observations has been instituted by M. Lespés on the *Termes lucifugus* of Bordeaux. We learn from these observations, which were begun in the autumn of 1855 and continued through the greater part of the year 1856, that M. Lespés concurs in the opinion already expressed in the preceding pages, that this species differs from the one found at La Rochelle, the latter having probably been imported from tropical regions. Among many other reasons that may be advanced in support of this view, he instances the fact that the damage effected by the Bordeaux Termites is very trifling when compared with the injuries inflicted by their congeners in the department of the Charente. Hitherto the *T. lucifugus* of Bordeaux has mainly limited its ravages to the old and decaying pine-stumps, which remain after each year's felling of timber in the *Landes* of Bordeaux; but it is not im-

probable that the abundance of this material may hitherto have been the means of saving the city itself from the inroads of these destructive insects, by affording them on the spot all the conditions favourable to the construction of their nests and the maintenance of their community.

The results of M. Lespés' observations seem to have led him to the conclusion that a Termite colony invariably consists of the following distinct classes: —

1. A fruitful pair, the parent king and queen, or a secondary and lesser king and queen (*petit roi et petite reine*).*

2. Neuters of two forms: workers and soldiers.

3. Larvas of two forms: sexual individuals and neuters.

4. Nymphas of two forms.

5. Sexual individuals, *winged* insects of two forms, which are destined to leave the nest: the May brood becoming the secondary or lesser kings and queens; while the August brood are the future parent kings and queens, destined to found new communities.

These classes may be grouped under two distinct heads, as *apterous neuters*, which embrace the workers and soldiers, and *winged sexual* individuals, which comprise the secondary or lesser kings and queens, and the parent kings and queens.

M. Lespés found workers and soldiers at all times

* M. Lespés was unable to satisfy himself as to the precise vocation of these lesser kings and queens, of which he sometimes found several couples in the same community, even where the nest contained a parent king and queen of larger size.

of the year; but about the end of May they were observed to have diminished very considerably both in numbers and size; and soon after this period the old insects had all disappeared and given place to a new generation of workers and soldiers; it would, therefore, seem that this class lives about a year after the final metamorphosis. The two forms of Nymphas appear in July; the first form undergo their final metamorphosis in the following May*; and the second form continue unchanged for a year beyond that period; hence, the perfect individuals live about twenty months before they attain their ultimate state.*

It would appear from M. Lespés' observations that all the different classes of Termites resemble

* These Nymphas belong, as already observed, to two forms; those of the first form have long and broad wing-cases, which cover all the anterior portion of the abdomen. They are considerably larger than the workers, and their heads, which are proportionally longer, are of a white colour, and are furnished with eyes. Those of the second form are of less frequent occurrence than the former, but they are both larger and heavier, and are distinguished by their shorter wing-cases. They are at first of a yellowish white colour, but they gradually acquire a darker hue, and in August, when they undergo their final metamorphosis, they are of a decided brown colour. The Nymphas of the first form, or those with long wing-cases, begin to change their colour, although not very decidedly, early in May; and, in about a fortnight afterwards, they are metamorphosed into winged insects, constituting the section of the perfect insects which M. Lespés denominated *les petits rois et petites reines.* The Nymphas of the second form, or those with short wing-cases, do not attain the perfect state till the month of August or September. After losing their wings, which they retain only for a few days, they become the parent kings and queens of new communities.

each other in their earliest stage; but the difference between the neuter and the sexual individuals begins already to be visible during the second condition of metamorphosis, the sexual individuals exhibiting, even at that early period, traces of wings.

On the workers devolves not only the labour of constructing the common habitation of the community, but also that of attending upon the Larvas and Nymphas, and probably also on the kings and queens. The metamorphosis of the Nymphas seems especially to call forth all their activity; for at these times the whole community is in a state of commotion, and even at the moment when the larval workers and soldiers are undergoing their final metamorphosis, the old workers may be seen busily employed in assisting their infantine brethren to disengage themselves from their skins. It would seem that the commonly received idea that the soldiers exert a supervision over the workers is not correct, at least in reference to the *Termes lucifugus*, and M. Lespés is anxious to make it understood that his remarks apply solely to that species. The soldiers of *T. lucifugus* are very different from those described by Smeathman; for their bite is not sufficiently virulent to inflict an injury, excepting on very small insects; and although in the combats waged between the Termites and true Ants, the soldiers exhibit great courage, and never let go their hold until they have severed their prey in two with their formidable pincers, they are generally vanquished and overcome by the numbers of their small

but fierce foes. It is not unusual in opening a nest of the *Formica cunicularia* to find numbers of dead Termites, chiefly workers and Larvas, in the galleries which contain the larval Ants, where they have been brought as food for the young of the community. This species might, therefore, be advantageously employed to exterminate the Termites of Rochefort. M. Lespés never found any stores of food in the nest, nor did he find anything in the nurseries resembling those fungoid growths which Smeathman described.

On taking a retrospective glance at these records of "The Rambles of a Naturalist," my thoughts have necessarily been led to dwell on the many varied events which have checkered my path during the years that have elapsed since I began to depict the impressions, and to record the observations yielded by those journeyings by sea and land, which are described in the present volumes.

In this review of the pains and pleasures of a period which stands widely apart from the ordinary routine of my existence, I have felt the joys and sorrows of years crowded into a few hours, and I have risen from this contemplation of by-gone days more and more deeply impressed with the conviction of the beneficent, calming and ennobling influences of the study of nature generally, and of the history of living beings more especially. The study of zoology, by bringing us constantly into the presence of the infinitely grand and varied problem of organisation, and by comprehending within the scope of

its contemplation both animal structures and that unknown agent which we term *life*, at once stimulates our reasoning powers and elevates our moral aspirations, and thus satisfies all the requirements of our double nature. And it is no doubt owing to the fact of this science appealing simultaneously to our intellectual and moral instincts that it exerts so powerful an influence over those who devote themselves in a humble and teachable spirit to its pursuit. In the preceding pages I have already frequently endeavoured to draw attention to the moral and religious ascendency which the study of living beings is calculated to exert over the human mind: and happy indeed shall I esteem myself if anything that I have said may have the effect of leading others to seek in the study of nature for solace amid the harrowing cares of life, or to turn to these ennobling pursuits for a confirmation of their faith, when the black mists of sophistry and scepticism threaten to dim the bright light of truth. Happy, truly happy, shall I be if any words of mine may be the means of leading one wearied spirit to seek for a balm for his wounds, or satisfaction for his wavering belief, in the study of those marvellous and exquisitely beautiful organisms which have their dwelling in the mysterious world of ocean! To find that new labourers are pressing forward to take their place in those fields of research from whence I have myself reaped so rich a harvest of pleasure and instruction, will be more than ample compensation to me for the pain it has cost me to retire from the direct pursuit of

paths of inquiry, which have yielded me so many moments of unalloyed enjoyment.*

* [M. de Quatrefages here alludes to his recent appointment to the Chair of Ethnology (*Histoire Naturelle de l'Homme*) at the Museum of Natural History in the Jardin des Plantes. While we congratulate M. de Quatrefages on this honourable recognition of his claims as a naturalist, we cannot help regretting, in common with all zoologists, that any circumstances should have withdrawn him from a department of natural history in which he had already achieved such signal success.]

APPENDIX.

Note I.

Elie de Beaumont, Perpetual Secretary to the Academy of Sciences, and Professor at the College of France, has undoubtedly exerted a greater influence on the course and progress of science than any other modern geologist. By reviving the ideas that had been first enounced by Stenon in 1669, and by giving prominence to the observations of Saussure * and Werner †, M. de Beaumont

* Saussure, who was born at Geneva in 1740, and died in 1799, was the nephew of Bonnet, to whom he very probably owed that taste for the natural sciences, which was still more strengthened by his association with Haller. As early as his twenty-second year he published a memoir, entitled *Observations sur l'Écorce des Feuilles et des Pétales.*

Notwithstanding the multiplicity of his labours, he returned after various intervals to his botanical studies, and his last memoir, read at the Academy of Geneva a few months before his death, had for its object the study of the "constant direction of roots and stems." Saussure occupied himself more especially with physics and geology, and he added to the former of these sciences a new branch, viz. *Hygrometry*, and also made some very valuable observations on the structure of high mountains, which distinguished him among the founders of geology. It is well known that he was the first who ascended to the summit of Mont Blanc.

† Werner, who was born at Welhau in 1750, and died at Dresden in 1817, was the son of a manager of iron works. From his childhood he had been familiar with minerals, and this circumstance very probably determined his future vocation. At the age of twenty-

was enabled, by combining the results of his own studies with the researches made by Humboldt and Leopold von Buch, to transform the vague idea of an upheaval of mountains into a complete doctrine, which has given a rapid impetus to the progress of geology, and enabled us to trace the past history of our globe with a precision that amounts almost to mathematical accuracy. By means of this doctrine we have been enabled to ascertain the relative age of mountain chains and other districts, and to determine their formation, to recognise the modifications which each new cataclysm has effected in the form of seas and continents, and finally to prepare geographical charts corresponding to epochs which very probably

four he published his first work, which, although it was only a short treatise of a few pages, on the classification of minerals, began a new era in the history of mineralogy, because it was the first attempt to reduce this science to a methodical system. Having been appointed almost immediately afterwards assistant, and subsequently full professor, at Freyburg, Werner, by the celebrity of his teaching, attracted around him a numerous band of pupils, and it is by them more especially that his doctrines have been promulgated, for their master exhibited a repugnance to the manual act of writing that amounted almost to mania. He would not even open the letters which were addressed to him, for fear of being obliged to answer them, and hence, in addition to the treatise of which we have already spoken, he has left only two other works, which in like manner consist of merely a few pages each, viz. *A Classification and Description of Mountains* and *A new Theory of the Formation of Metalliferous Veins*. Werner had more particularly occasion to notice sedimentary rocks, and hence he was led to ascribe a very exaggerated influence to water in the formation of the earth's crust. Thus, for instance, he assigned an aqueous origin even to basalt, and he therefore justly merited to be regarded as the chief of the *Neptunian* school. This celebrated mineralogist was passionately attached to his native country, and it is asserted that the misfortunes experienced by Saxony in 1812, caused him so much grief as to accelerate the progress of the disease from which he died.

preceded by many millions of centuries the appearance of Man upon the earth. These results, however marvellous they may appear, are based upon such solid proofs, that they may be regarded as much more certain than many portions of Greek and Roman history. M. de Beaumont has not limited himself to the establishment of the principles which have led to these consequences. He has added to their demonstration by numerous memoirs which have appeared in different publications, amongst others in the *Annales des Sciences Naturelles, Bulletin de la Société Géologique de France* and the *Annales des Mines.* He has also published an abstract of his fundamental views, first in an elaborate article in the *Dictionnaire Universel d'Histoire Naturelle,* and subsequently in a special work, which was more particularly intended to show their mathematical application. Finally, M. de Beaumont has commenced the publication of a work which is not yet completed, entitled *Traité Général de Géologie.*

The theory first advanced by M. Elie de Beaumont in reference to the formation of Etna, has given rise to much controversy among geologists. We shall, however, follow the views which he advanced in the memoir to which we have already referred. We shall have no difficulty in justifying our adherence to his theory, for this distinguished geologist was the first to recognise a great number of important facts, resulting from the examination of Etna, and which had escaped the notice of his predecessors. Our own observations fully accord with the deductions which he has drawn from his investigations. The exactness of these observations is farther confirmed by the magnificent work of the German geologist, Sartorius von Waltershausen, who devoted six years to the study of this volcano, and who has published a minutely detailed map of the mountain, which is accompanied by drawings of the greatest exact-

ness. M. Elie de Beaumont has made an excellent model of the volcano, which is based upon his own observations, and he has faithfully represented all the various aspects of the mountain in plates which accompany the work, from which we have made numerous extracts.

Note II.

Few names are more celebrated in modern science than that of Humboldt — a name which has been rendered illustrious by two brothers, who appear together to have compassed the entire range of human knowledge. Notwithstanding the diversity of their labours, there is a striking analogy between the tendencies of these two minds. The elder, Wilhelm von Humboldt, directed his attention to literature, more especially in its scientific bearings, whilst the younger, Alexander von Humboldt, devoted his attention more exclusively to the natural sciences, although both took broad and general views of the subjects which they investigated, regarding the special departments of the various branches of knowledge which they cultivated simply as means of arriving at more general points of view. As the sons of a German father and of a mother who was partially of French descent, the brothers seem to have appropriated to themselves all the best features of the genius of both nations, while they wrote with equal facility in both languages. Their labours may very probably have been of equal importance, but the name of Alexander von Humboldt is at once more popular and more distinguished, partly in consequence of his labours having harmonised with the tendencies of our age, and partly in consequence of the important results which he attained by the bold and novel direction which he gave to his researches.

Wilhelm von Humboldt was born at Potsdam in 1767,

and died at Tegel in 1839, while in the act of reciting an ode of Pindar. He always appears to have combined the most abstruse studies with a practical attention to politics, and while he was prime minister of his native country, he also occupied one of the first places among the philologists of Germany. The comparative study of languages at all times constituted his favourite pursuit, and he has left numerous traces of his learning in this department of knowledge. The language and population of the Basque countries offered a curious problem, which he endeavoured to solve by assiduous researches carried on in the Basque country, where he resided for a long time. The fruit of his researches first appeared in a work, entitled *Researches on the primitive inhabitants of Spain, based on the Basque language.* He also published a vocabulary of this tongue, and enriched the work of Adelung with numerous additions and corrections bearing upon the same subject.

Alexander von Humboldt has survived his brother, and is now one the patriarchs of science. He was born in 1769, a memorable year, which also gave birth to Chateaubriand, Cuvier, and Napoleon. He prosecuted his classical studies under the direction of Forster, who had served as naturalist in one of Captain Cook's voyages, and it is very probable that he derived from his intercourse with his master, that love of science and of distant travel which old age has scarcely extinguished. At the age of twenty-three he was appointed director of the mines of the Fichtelgeberge, and one year afterwards he published a memoir on the fossil flora of the district. A sedentary life did not, however, suit the tastes of Forster's pupil, and the young von Humboldt having soon tendered his resignation, travelled through a great part of Europe sedulously devoting himself to the study of all branches of science, and thus endeavouring the better to prepare

himself for a great expedition through the Peninsula of Southern Asia, a plan which had formed the most ardent aspiration of his life.

These aspirations, however, were never realised. Having hoped to reach the Red Sea by passing through Egypt with Bonaparte's army, he hastened to Toulon with the view of joining that expedition, but he unfortunately arrived only in time to see the last ship of the squadron disappear in the distance. He then made a vain attempt to rejoin the French army by following the native caravans, but being again disappointed, he determined to proceed to Asia by way of America, and this was the cause of his departure for the New World; but after he had once set foot on the American continent, he saw himself surrounded by such vast natural riches, that for the moment he lost sight of his favourite project. During five years, he continued to explore the vast rivers and great mountains of Southern America, and having reaped a rich harvest of materials, he was anxious to turn them to the best account. He chose Paris as the place in which to publish the result of his labours, and having been received with the greatest cordiality by the most illustrious savants of that distinguished period, he remained for a long time in this city, which he has since regarded as a second home.

Alexander von Humboldt repeatedly attempted to accomplish his great voyage to India, but his wishes always met with the decided opposition of the English Government, notwithstanding the direct intervention of their ally the King of Prussia. As he was unable to explore the south of Asia, he contented himself with visiting the northern regions of the Asiatic continent. In 1819 the Russian Government wished to explore the vast countries which it possesses in those regions, and which had hitherto been very little known. Humboldt having heard of their

intention, offered to lead an expedition into Siberia and Central Asia, and his proposals were accepted without a moment's hesitation. He was thus enabled to compare the steppes of the Obi with the pampas of Brazil and the plateaux of the Altai with the llanos of the Cordilleras.

From this period Baron von Humboldt undertook no other great expeditions, devoting the whole of his energy to more proximate objects. As the friend rather than the subject of the kings who have succeeded one another on the throne of Prussia, he has always made his high position and influence serviceable in the cause of science. He has enriched his country with numerous scientific establishments and institutions, and it is to him that we owe the foundation of a vast association whose centre is at Gœttingen, and which has for its object the study of terrestrial magnetism, by the aid of observations regularly conducted in all parts of the world.

The works of Baron von Humboldt are at once extensive and varied; there are few sciences on which he has not written, and he has never treated of any subject without leaving upon it the impress of his great genius. Having, moreover, made general physics the focus in which he centered all these varied branches of learning, he has gained for himself one of the most distinguished places in this difficult and great department of human knowledge. As a traveller and a physicist, Baron von Humboldt must rank with the great masters and founders of modern science. Everyone is aware that he has thrown the rich treasures of his intellectual life into a work entitled *Cosmos*, which, originally written in German, has been translated into several European tongues.

Note III.

The history of science presents few names more illustrious than that of Jussieu. For more than a century and a half the members of this family have distinguished themselves in the first rank of botanists, and one of them has exercised over botany and over the natural sciences generally an amount of influence which can never be effaced.

Antoine de Jussieu, who was born at Lyons in 1686, and died at Paris in 1758, was Professor at the Jardin du Roi.

He left various works, amongst others an *Appendix to Tournefort.*

Bernard de Jussieu, his younger brother, was born at Lyons in 1699, and died at Paris in 1777. He accompanied his brother in a journey through Portugal to collect plants, and he then acquired so ardent a love for botany that he devoted himself exclusively to that science. Happy in the humble situation of sub-demonstrator, which permitted him to manage the botanical garden at his pleasure, and to collect plants in company with the pupils to whom he communicated his own taste for study, and to whom he made known all his discoveries, Bernard de Jussieu never sought to obtain renown by the publication of his observations. His answer to those who informed him that his discoveries were claimed by others was invariably, "Qu'importe, pourvu que la chose soit connue?" nor could his friends ever induce him to do more than publish a few isolated memoirs. Nevertheless he was always deeply interested in general questions and amongst others in that problem of a natural method which the great Linnæus had declared impossible of solution. Having been named in 1759 superintendent of the gardens at the Petit-Trianon, Bernard

de Jussieu arranged the plants according to his own ideas, but he never published anything which could give a key to this arrangement, and those botanists who came to Trianon to study his learned enigma were never enabled to solve it. Bernard died blind, leaving to his nephew Laurent the results of his studies.

Laurent de Jussieu, who was born at Lyons in 1748, and died at Paris in 1836, was worthy of such a heritage. At the age of seventeen he began his studies under his uncle, and at the age of thirty he entered the Academy of Sciences. Having at the same time been named assistant to Lemonnier, professor of botany in the Jardin du Roi, he began to reform the arrangement of the school of botany, and to apply to it his own and his uncle's ideas in reference to the natural method. For thirty years he continued to develop these views, and when in 1778 he began the publication of the *Genera Plantarum*, which was terminated in 1789, the science of botany was definitely established. Notwithstanding the difficulties which the new method presented in certain respects, and notwithstanding the convenience of the Linnæan system, and the great name of its author, the ideas of Jussieu prevailed, and are now universally adopted. They have, moreover, extended their influence to all the other branches of the natural sciences, and with respect to zoology more particularly it may be said that in certain respects Cuvier was merely the follower of Jussieu. He rendered another great service to the natural sciences by founding the library of the Museum, which is now so rich in standard works. In 1826 this illustrious botanist became blind like his uncle, and resigned his professorship to his son Adrien. This last scion of the family, who was a member of the Institute, was born at Paris in 1798, and died in same city in 1853. From his earliest youth, Adrien had given proofs that the

name of his father and great uncles would find a worthy representative in him. As a youth he carried off the the first prize in the *concours* which takes place every year among the colleges of Paris, and as a young man he presented as his thesis for the degree of doctor in medicine a memoir on the family of the Euphorbiaceæ which attracted the attention of all botanists. Subsequently in his researches on the Rutaceæ, Meliaceæ and Malpighiaceæ, he developed still further the most marked qualities of a sagacious and profound intellect. In these different memoirs, and especially in the last, the author accompanied the description of the species with a full account of the anatomy of the organs and their physiological functions. A memoir on the embryo of the Monocotyledons, a work of very considerable extent, was to have formed the first of a series of publications on similar subjects, for which the author had collected a very large amount of materials, but ill health prevented the realisation of this and many other projects. Adrien de Jussieu published a *Cours Elémentaire de Botanique* which was speedily translated into all the principal European languages. It was his intention to have extended this work into a complete and general treatise, and it is much to be regretted that the prosecution of this object was arrested by his death.

Adrien de Jussieu rendered continual services to science, not only by his writings but by his teaching. In the various botanical excursions which he undertook he was often accompanied by distinguished men who rejoiced in the opportunity of witnessing that display of profound learning, combined with one of the most amiable and gentle natures, for which he was remarkable. These characteristics insured to Adrien de Jussieu the attachment of all who were brought in contact with him. The esteem of his colleagues led them to resign to him

the entire management of the Jardin des Plantes, and he had been named president of the Academy of Sciences very shortly before his death. As Adrien de Jussieu has left no sons to inherit his name, in him is extinguished a scientific dynasty which for three generations has constituted the glory of the Academy of Sciences and of the Jardin des Plantes. (See the *Notices* of M. Adrien de Jussieu by MM. A. Brongniart and Décaisne.)

THE END.

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